LANDSCAPE AMENITIES

AND

LOCAL DEVELOPMENT

Dissertation

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The Faculty of Economics, Business Administration and Information Technology of the University of Zurich hereby authorises the printing of this Doctoral Thesis, without thereby giving any opinion on the views contained therein.

Zurich, 21 September 2011

Chairman of the Doctoral Committee: Prof. Dr. Dieter Pfaff

Preface

As an external doctoral student at the Faculty of Economics, Business Administration and IT, I started to work on this doctoral thesis during my time at the Institute of Environmental Sciences (University of Zurich) where I was employed as a collaborator in PD Dr. Felix Schläpfer's research project "How publicly provided landscape resources and historical heritage affect local economic change". The project started in 2005 and was financed by the Swiss National Science Foundation. In July 2008 I joined the Swiss Federal Institute for Forest, Snow and Landscape Research WSL where I have since been working as a research associate in the Economics and Social Sciences research unit.

During the time I was working on this doctoral thesis I benefited from the help and moral support of numerous people. First and foremost, I am grateful to PD Dr. Felix Schläpfer and Prof. Dr. Peter Zweifel. PD Dr. Felix Schläpfer was my thesis advisor and has coauthored two chapters of this thesis. I was able to benefit a lot from his scientific experience as well as from his ongoing dedication. Prof. Dr. Peter Zweifel was my thesis supervisor/faculty referee; he provided me with valuable advice and indispensable comments. In addition, I would like to thank Prof. Dr. Ulrich Woitek, my thesis co-supervisor, who was always very helpful and supportive. Moreover, I have had inspiring contact with several experienced researchers in the field of amenities and regional development and would like to thank Dr. David McGranahan and Prof. Dr. Steven Deller in particular.

I would also like to thank Prof. Dr. Bernhard Schmid – the director of the Institute of Environmental Sciences – and PD Dr. Irmi Seidl and Dr. Marco Pütz, my superiors at the Swiss Federal Institute WSL, for their continuing support.

Of course I would also like to mention present and former work colleagues and office mates: Daniel Baumgartner, Gianluca Menghini, Thomas Schulz, Eva Vojtech,

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F.W., Zurich, March 2011

Contents

Chapter 1

Introduction

"I want to make it clear, if there is ever a conflict (between environmental quality and economic growth), I will go for beauty, clean air, water, and landscape."

(Jimmy Carter, quoted in the New York Times, September 19, 1976)

A growing number of empirical studies from the U.S. have concluded that location-specific quality of life factors continue to gain importance in residential location decisions as well as in the location decisions of firms. The main drivers that have been identified are lower mobility costs through advances in IT and transportation technology, globalization, a rising number of households with footloose incomes, and a generally rising level of wealth and income (Cherry and Rickman, 2010). Local landscape resources are one factor that is relevant to quality of life. With rapid urban expansion and loss of open space, attractive local landscapes are an increasingly important consideration in location decisions and on political agenda. For example, agricultural policies in Europe have shifted from a pure production orientation towards multifunctionality and agricultural subsidies increasingly compensate for the provision of ecosystem services and environmental amenities. Moreover, new regional nature parks and protected areas are being established, which is often connected with the hope of attracting skilled residents and creating added value within the region. However, even though the management of amenities is increasingly seen as a growth tool supporting regional development, the impact of landscape amenities and landscape-related policies on local economic development in Europe remains widely unexplored.

This collection of essays deals with the question of how landscape and land use affects local and regional development. In Chapter 2, the literature on landscape amenities and local development with a focus on the relationship between amenities and macro-indicators of regional growth (population, employment, income), is reviewed. In a second part of Chapter 2 the evidence on implicit prices of different landscape elements as reflected in housing prices is summarized. The subsequent chapters expand on the empirical literature reviewed in Chapter 2 by analyzing the impact of landscape amenities on population and employment growth (Chapter 3) and on apartment rental prices (Chapter 4) in Switzerland. Switzerland qualifies as an excellent study region due to its high diversity of local conditions, the availability of nation-wide land-use data and the comparability of its landscapes and land-use policies with those in other European countries.

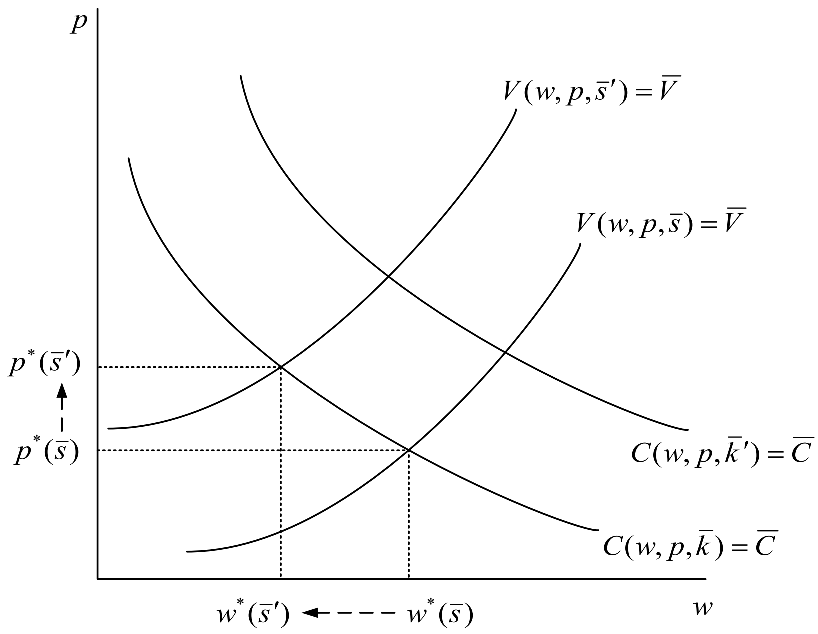
The first essay, titled "Landscape amenities and local development: A review of migration, regional economic and hedonic pricing studies" (Chapter 2), analyzes the revealed preference literature on the topic of landscape amenity impacts on development. Two major strands of empirical research are considered: migration and regional economic models, and hedonic pricing models. Reported effects of landscape amenity variables on migration, population growth, employment growth, income growth, and housing prices were systematically assessed and analyzed in a semi-quantitative framework. The reviewed migration and regional economic studies suggest that migrants are attracted by amenities nearly as often as by low taxes. However, reported effects of amenities on income and employment are less consistent. The hedonic studies suggest that nature reserves and land cover diversity have mostly, open space and forest often, and agricultural land rarely positive effects on housing prices. Studies at larger geographic scales and studies involving urban areas were more likely to identify significant amenity effects. Some limitations of the evidence may be overcome with better datasets and modeling approaches. However, the limitations also highlight the need for complementary information from the analysis of political preferences for land-use management. Moreover, the vast majority of the compiled studies have analyzed data from the U.S. while European evidence is scarce. Chapters 3 and 4 contribute to filling this gap by studying the impact of landscape amenities and related policies on local development and apartment prices in Switzerland.

In Chapter 3 titled "The role of landscape amenities in regional development: Evidence from Swiss municipality data", a regional adjustment model (Carlino and Mills, 1987) is applied to data from 2467 municipalities in Switzerland to examine how landscape amenities and related policies affected development, along with fiscal, demographic and infrastructure variables, in the period from 1995 to 2005. The structural simultaneous equations model is estimated using the three-stage least squares (3SLS) estimation procedure and tested for local and global spatial autocorrelation. While the relationship between the "traditional" locational factors and population growth are largely compatible with the theory on internal migration and regional development, it is shown that population was positively affected by the proximity to major lakes and by the abundance of open space. However evidence of positive effects of traditional landscape elements such as extensive orchards and vineyards is limited. The drivers of the spatial distribution of jobs are considerably different. Employment growth was consistently affected by demographic factors and accessibility but not by the landscape amenity variables, except that employment grew less in municipalities that are part of an inventory of nationally significant landscapes. The lack of measurable local benefits from nationally significant landscapes and townscapes suggests that policies to preserve these amenities should be implemented and financed by the national government.

A caveat to the regional adjustment model that is applied in Chapter 3 is that it does not control for spatial differences in wages and housing prices. Following Roback (1982) and Wu and Gopinath (2008), Fig. 1.1 illustrates the spatial equilibrium level of wage (w) and housing price/rent (p) in locations with different levels of amenities ($s' > s$) and capital ($k' > k$). Given fully mobile, utility-maximizing households and fully mobile cost-minimizing firms, the spatial equilibrium is characterized by spatially equalized utility (V) and production costs (C). Keeping capital (k) and the associated iso-cost-curve constant, a location L' with amenity endowment $s' >$ s has higher housing prices $p^{*\prime}$ and a lower wage level $w^{*\prime}$ than location L (p^*, w^*). Hence, in spatial equilibrium, housing prices and wages compensate for regional differentials in the abundance of location-specific amenities (Roback, 1982). The importance of location-specific amenities may therefore be underestimated when observing the location decision of firms and households.

Fig. 1.1

Wages and housing prices in the spatial equilibrium.



In Chapter 4, titled "How local landscape resources affect apartment prices: Evidence from a hedonic pricing model", the capitalization of landscape resources in apartment prices is measured using data from 956 municipalities distributed all over Switzerland. Along with property-level attributes, the analysis includes a broad set of GIS[1]-based municipality-level variables, which represent location-specific amenities and other neighborhood features. The results show that several aspects of landscape and townscape management, as well as natural amenities, have a strong impact on apartment rents. Specifically a southern exposition, lake view, open space, historical heritage and land for recreational activities play an important role in determining the attractiveness of a location. Furthermore the results support the idea that settlement pressure, which is also reflected in rents, tends to increase the population's sensitivity towards landscape changes.

Note that Felix Schläpfer co-authored Chapter 2 and 3 and Thomas Schulz co-authored Chapter 3 and 4. While the undersigned author was at least equally responsible as his co-authors for the intellectual input to Chapters 2 and 3, the main contribution to Chapter 4 is by Thomas Schulz. Chapter 2 was published in *Ecological Eco-*

[1] Geographic information system

nomics and Chapter 3 will appear in 2011 in *Land Use Policy*. Chapter 4 has working paper status and will be revised and submitted to an environmental economics or environmental management journal as soon as possible.

Fabian Waltert
Zurich, March 2011

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Landscape Amenities and Local Development: A Review of Migration, Regional Economic and Hedonic Pricing Studies

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Chapter 2

Landscape Amenities and Local Development: A Review of Migration, Regional Economic and Hedonic Pricing Studies

2.1 Introduction

Traditional regional economic and migration studies largely ignored the possible effects of location-specific environmental amenities on demographic and economic change. Starting in the 1970s, however, two fundamental changes in U.S. internal migration patterns occurred (Greenwood, 1985): first, net-migration flows turned from the Northeast to the amenity-rich southern and western states; and second, the population growth in non-metropolitan regions started to exceed that of metropolitan areas.[1] Searching for explanations of these developments, an increased demand for location-specific amenities – resulting from scarcity of natural amenities caused by urbanization as well as generally rising real incomes – was identified as one of the possible causes (Deller et al., 2001; Greenwood, 1985). Since that time, economists and regional scientists have shown an increasing interest in the role of environmental amenities in local and regional development. New modeling approaches such as regional growth models in a system-of-equations framework allowed them to explore the links between amenities, population, and economic development.

[1] This pattern changed in the 1980s when there was a revival of metropolitan net migration. However, in the 1990s net migration flows were in favor of rural areas again (see Fuguitt and Beale, 1996).

If amenities are at least partly capitalized in housing prices, their role for local development will be underestimated in regional economic and migration models (McGranahan, 2008). Hence, hedonic pricing models constitute an important complementary source of information on the role of environmental amenities. Although traditionally a separate literature, hedonic pricing studies that account for amenities can thus provide important additional insights on amenity-driven processes measured at the community and county level.

While early contributions in these fields used relatively limited amenity measures that included mainly climate amenity attributes or disamenities such as air and water pollution, it was in the 1990s when empirical researchers began to explore the role of a wider range of specific measures of natural and environmental amenities. Around that time, periurban amenities also gained increased interest in public policy as a factor that contributes to the quality of life and may be relevant to firm location decisions (e.g. Beyers and Lindahl, 1996; Cavailhès et al., 2004; Gottlieb, 1995; Johnson and Rasker, 1993). Governments started to shift agricultural support policies from producer support towards compensation for the provision of environmental amenities, and several researchers highlighted the management of natural amenities as a development tool for rural regions (e.g. Deller et al., 2001; Feinerman and Komen, 2003; Fuller et al., 2005; Green, 2001). Moreover, environmental amenities are increasingly seen as important determinants of urban and rural spatial development patterns and phenomena such as urban sprawl and leapfrog development (e.g. Wu, 2006; Wu and Gopinath, 2008).

The objective of this study is to survey the growing literature on the role of landscape amenities in regional and local demographic and economic change. A survey on this topic is of interest for several reasons: (1) while single studies can provide evidence for amenity impacts in the study regions it often remains open to what extent their findings are representative of more general patterns and processes. A synthesis of evidence can contribute to a better general understanding and may allow insights on whether results can be transferred to other regions. (2) With growing political awareness of the importance of landscape as a public good and a locational factor contributing to quality of life there is an increasing need for broader scientific assessments on which to base public decisions in landscape management. (3) Synthesis of the literature helps to identify the state of the art and future research needs and provides a basis for conclusions about the potential and limitations of the empirical approaches.

Following common amenity definitions (e.g. Deller et al., 2001; Gottlieb, 1995; Green, 2001; Marcouiller and Clendenning, 2005) we define natural landscape amenities as landscape features that are location-specific, latent non-market input goods of an economy that directly enter a resident's utility function or attract firms in amenity-related industries.[2] We seek answers to two main questions. (1) Do landscape amenities promote population growth and economic development, and what is the importance of amenities relative to other economic factors? We analyze the available empirical literature using migration models and models of regional growth to provide an overview of evidence on the links between landscape amenities, population growth, and economic indicators (25 studies). (2) Which landscape amenity attributes are capitalized in housing prices? To answer this second question, we compile and analyze evidence from the hedonic pricing literature on landscape amenities (46 studies). Based on the results, we discuss main insights but also remark on limitations of the literature as a basis for public decisions.

The remainder of this chapter is composed of six sections. In the next section, we review the theoretical frameworks and empirical approaches in the migration, regional economic, and hedonic pricing literature. The following section contains the definitions and selection criteria used in compiling and analyzing the empirical studies. In section 2.4 and 2.5 we then review the empirical evidence. The two final sections present a discussion and the conclusions.

2.2 Models of amenity effects

2.2.1 Amenities and migration: Equilibrium and disequilibrium view

Traditional micro theory views migration as a reaction to spatial *disequilibria*. People migrate in order to reach higher utility. They react to regional differences in economic opportunities, for example by migrating from low- to high-wage regions. Hence, in the

[2] The detailed selection criteria for the landscape amenity studies reviewed in section 2.4 and 2.5 are described in section 2.3.

disequilibrium view, migration is mainly a function of labor market variables. Since regional differentials are assumed to be associated with spatial disequilibrium, such differences in wages, rents or employment are sometimes referred to as *noncompensating differentials* (Hunt, 1993). Noncompensating differentials thus encourage migration as an equilibrating mechanism. An extensive body of literature on disequilibrium models has been built up since the early 20th century. Surveys are provided by Greenwood (1985) and Hunt (1993). Amenities play virtually no role in traditional disequilibrium models.

In the late 1970s, an alternative model approach evolved, which has its roots in urban economics. In contrast to disequilibrium models, the *equilibrium* models allow for spatial differences in economic opportunities even in a spatial equilibrium. One of the first advocates of the equilibrium view was Graves, who explains the underlying rationale as follows (Graves, 1980, p. 227): "In this view of migration, market rents and wages are expected to adjust so as to leave utility constant over space. Hence, within a city rent differentials will emerge to remove any advantages associated with access to the center, parks and the like, while across cities wages will be lower in desirable areas by an amount equivalent in utility to the amenities obtained by locating there. Migration, viewed in this way, takes place as a result of changes in demand for location-fixed amenities." Spatial differences in wages or economic opportunities are viewed as compensation for different amenity endowments. Hence, such differences are commonly referred to as *compensating differentials,* since they are of purely compensating nature and do not induce migration (Greenwood et al., 1991). The crucial explanatory variables in equilibrium migration models are amenity variables and factors that may lead to changes in demand and supply of amenities. These factors include growing real incomes (see Graves and Linneman, 1979) combined with the generally assumed high income elasticity of demand for amenities (e.g. Marcouiller and Clendenning, 2005), as well as changing relative prices, which lead the system to a new equilibrium. Such adjustment processes are believed to occur relatively quickly, unlike those associated with the disequilibrium approach, where the tendency towards equilibrium is assumed weaker and the migration process and factor markets are viewed as less efficient (Hunt, 1993). Knapp and Graves (1989) provide an extensive review of equilibrium models.

Whether equilibrium or disequilibrium models are more appropriate for modeling migration is at least partly an empirical issue. Hunt (1993) analyzes the empirical literature related to this question. He finds evidence in favor of both approaches. Both the amenity consumption and the job search motive seem to determine migration, while the relative importance of the two motives remains unclear. However, it is important to note that most early studies and some of the newer studies use relatively narrow amenity measures containing only few amenity types such as climate or water variables, or disamenities such as air pollution and crime (e.g. Clark and Murphy, 1996; Mueser and Graves, 1995). Since the econometric evidence supports the idea that amenities are capitalized in wages and rents and that migration is partly amenity driven, Hunt (1993) concludes that pure disequilibrium models are misspecified. On the other hand, in most studies, economic opportunity variables are found to be significant migration determinants, which imply spatial disequilibrium and inefficient markets.

2.2.2 Regional economic models of amenity effects on population, employment and income

Natural amenities receive a growing attention not only in migration economics but also in the literature on regional growth and change. This literature explores the impact of location-specific amenities both on population and on the local or regional economy as a whole. The literature suggests that there are several direct ways through which amenities can affect local and regional development. (1) Amenities may attract in-migrants with footloose incomes (e.g. Booth, 1999; Clark and Hunter, 1992; Poudyal et al., 2008). (2) Amenities may attract in-migrants who reveal their willingness to pay by accepting lower wages or higher rents (e.g. Judson et al., 1999; Roback, 1982, 1988). (3) Amenities may attract entrepreneurs who show their willingness to pay by accepting lower profits (e.g. Beyers and Lindahl, 1996; Johnson and Rasker, 1993). (4) Amenities may provide a basis for recreational and outdoor industries (e.g. Deller et al., 2001; Vanslembrouck et al., 2005). (5) Amenities may provide ecosystem services which directly enter individuals' utility functions or affect profits (e.g. Pimentel et al., 1995). In addition to those direct effects, amenity-induced population or job growth again may have indirect effects, for example by attracting skilled labor which in turn attracts firms (e.g. Gottlieb, 1995).

To model the impact of amenity and other exogenous variables on multiple dependent variables such as population, employment and income change, as well as interactions of those dependent variables, system-of-equations models are often employed. Models of this type have traditionally been used to explore empirically whether people follow jobs or jobs follow people (e.g. Steinnes and Fisher, 1974).

Carlino and Mills (1987) apply Steinnes and Fisher's intraurban system-of-equations model to an interregional context in order to explore the determinants of county growth in the U.S. This model has the following underlying assumptions on household and firm behavior: Households and producers are geographically mobile and choose their location in order to maximize their utility or profits, respectively. Consumer utility is derived from goods and services as well as from non-market, location-specific amenities. Firms maximize their profits by optimizing production costs and choice of a regional market. The result is an adjustment process in which "firms enter and leave regions until profits are equalized among regions at competitive levels, and households migrate until utility levels are equalized at alternative locations" (Carlino and Mills, 1987, p. 40).[3] Hence, such regional adjustment models compromise between the equilibrium and the disequilibrium view (see section 2.2.1). The theoretical existence of a spatial equilibrium is acknowledged. However it is assumed that the system is constantly in disequilibrium, e.g. through continual exogenous shocks (Carruthers and Mulligan, 2007, pp. 81–83).

Early contributions to this line of research used regional dummies as proxies for location-specific amenities (e.g. Carlino and Mills, 1987) or climate variables and costal dummies (e.g. Clark and Murphy, 1996). In the 1990s researchers started to include also specific measures of local land use such as amount of open space or forest land among the amenity variables. Such extension may be essential for the empirical validity of the Carlino-Mills approach, as stressed by Graves and Mueser (1993, p. 78): The Carlino-Mills model "assumes that measured variables fully determine the ultimate equilibrium population. If there are any unmeasured stable differences between locations […], this imparts a systematic bias that will reduce the apparent speed of move-

[3] A detailed microeconomic derivation of the system of equations and its underlying assumptions is provided by Steinnes and Fisher (1974).

ment toward equilibrium." Graves and Mueser explicitly note natural amenities and land rents as essential and often wrongly omitted variables. Among the most influential applications of Carlino and Mills' framework is the study by Deller et al. (2001) who add an equation for per capita income and use a variety of natural and non-natural amenity measures. Depending on whether the focus is solely on the direct amenity effects or also on the interplay of the endogenous variables, these studies estimate reduced forms of the model (e.g. Deller et al. 2001) or use simultaneous equations estimation methods such as two-stage least squares (e.g. Duffy-Deno, 1998) or the three-stage least squares technique (e.g. Lewis et al., 2003) to estimate the structural coefficients.[4]

An influential methodical advance was the development of spatial econometric techniques which were first applied to a regional growth model by Boarnet (1994) and subsequently used in studies on effects of amenities on regional change (e.g. Kim et al., 2005; Nzaku and Bukenya, 2005) or net migration (e.g. Ferguson et al., 2007; Rupasingha and Goetz, 2004). Recently, Partridge et al. (2008) used a geographically weighted regression (GWR) approach to study the impact of (non-landscape) amenities and other variables on employment growth in U.S. nonmetropolitan counties with focus on spatial heterogeneity.

2.2.3 Amenities, rents, and wages: Hedonic pricing models

Alongside the migration and regional economic models introduced above, hedonic pricing (HP) models are a further model type which contributes to the understanding of the role of amenities in economic change. The analysis of migration reflects the role of amenities on local economic change only partially when effects on property prices and wages are not considered. Furthermore, HP models allow comparing the implicit values of different amenity types by exploring preferences from property price data. The HP approach, whose theoretical framework was established by Rosen (1974), derives price equations from property sales data by regression and thereby allows valuation of different exogenous attributes of the property itself and its vicinity. Underlying this method is the equilibrium view introduced in section 2.2.1. Given mobile workers and

[4] An up-to-date description of specification and interpretation issues in regional economic system-of-equations models is provided in Carruthers and Vias (2005).

mobile firms in a spatial equilibrium, spatial differences in land prices and wages compensate for differentials in the amenity endowment (Roback, 1982). Freeman (1979) provides a survey of HP theory and early HP studies. The hedonic price function typically describes the property price as a function of three categories of independent variables: structural, neighborhood, and environmental attributes. One subcategory of environmental variables is amenities. The first step in an HP study is to calculate the implicit price of the attributes of interest by hedonic regression. Using this information and data for observed quantities and income, inverse demand and marginal willingness to pay functions can be estimated in a second step (Freeman, 1979). In most amenity HP studies, this second step is omitted. Exceptions are e.g. Day et al. (2007), Garrod and Willis (1992), Mahan et al. (2000) and Poudyal et al. (2009a).

Contrary to migration and regional economic approaches, the HP method can reveal preferences for specific amenity types at small spatial scales. Hence, also effects of accessibility, distance or visibility of amenity features can be captured. This high spatial resolution usually comes at the cost of limited spatial coverage meaning that HP studies often cover only one neighborhood, community, or county.

The interpretation of hedonic property value studies has some limitations. As shown by Roback (1982, 1988) and subsequent empirical work, amenities may be capitalized not solely in property prices but also in wages. Consequently, single-market studies may underestimate amenity values (Graves and Knapp, 1985).[5] Another issue is that the assumptions underlying the hedonic technique, in particular the assumption of equilibrium in the housing market, are criticized. Furthermore, there are some critical econometric issues. Estimation results are sensitive to the choice of the functional form, which cannot be purely theoretically determined (Rosen, 1974). A more recent issue concerns the consequences of spatial autocorrelation resulting from spatially correlated omitted variables or spatial externalities. Its neglect in HP or other spatial data can lead to inefficient estimates and biased standard errors (Leggett and Bockstael, 2000) and therefore may demand alternative specifications or the estimation of models which explicitly incorporate spatial effects, such as *spatial lag* or *spatial error* models (see e.g. Anselin, 1988, 2002; Anselin and Bera, 1998). Can (1992), Dubin (1992), and

[5] Nevertheless, multi-market HP studies containing landscape amenity variables as defined in section 2.1 are rare. Of the studies reviewed in section 2.5 all but one (Hand et al., 2008) are single-market hedonic property value studies.

Holloway et al. (2007, pp.557–559) discuss spatial econometric issues specifically in HP models.

2.3 Definitions and selection criteria

In this section, we provide definitions and article selection criteria which we then apply in compiling and analyzing the empirical literature.

As outlined in the introduction, we focus on landscape features that are location-specific, latent non-market input goods of an economy and directly enter a resident's utility function or attract firms in amenity-related industries. Landscape amenity attributes are demanded for their recreational and aesthetic utilities rather than as raw materials used in the production process. Examples of such attributes are agricultural land, forests, wildlife habitats, natural preserve areas, wetlands and open space. Other commonly analyzed amenity attributes, such as climate (e.g. Graves, 1980), air quality (e.g. Harrison and Rubinfeld, 1978), watercourses (e.g. Colwell and Dehring, 2005), and "non-natural" green space such as city parks (e.g. Tajima, 2003), are not the subject of our analysis, although they may likewise affect economic change. A further prerequisite is that natural landscape amenities must be identifiable and are not part of a broader composite index that also contains, for example, non-environmental amenities.

All articles we analyzed use revealed preference models relating landscape amenities (see definition in section 2.1) to regional or local economic change in developed countries. The literature considered in this survey consists of three different model types: Migration models, regional economic models and HP models. The survey includes articles published in peer-reviewed journals between 1970 and 2009. We found most articles by searching the databases *Web of Science* and *Econlit*.[6] We used several combinations of the following keywords: (1) resource keywords: landscape, open space, amenities, natural, federal land, preservation; (2) model keywords: Carlino, hedonic; and (3) other keywords: population, migration, employment, income, growth, wage. Using these queries we found several hundred articles of which 71 (25 regional economic and migration studies and 46 hedonic pricing studies) used land-

[6] Additional literature was searched by consulting the references of relevant articles. Some of the HP studies were found in a review paper on open space valuation (McConnell and Walls, 2005).

scape amenity variables consistent with our definition (see section 2.1) and fulfilled all criteria concerning model type, data origin, research question and source defined above. With the exception of seven HP studies and four recent regional economic and migration studies, all studies in our sample use U.S. data.[7]

2.4 Empirical evidence from regional economic and migration models

The regional economic and migration studies analyzed in this section are heterogeneous in several dimensions: by model type, amenity variables, dependent variables, geographical coverage and the estimation method employed. We analyzed the evidence in a semi-quantitative review of reported effects. Specifically, we examine the frequencies of significant reported amenity impacts on population/migration, employment and income variables, and we compare these with the impacts of fiscal and economic opportunity variables.

2.4.1 Study sample and amenity types

Based on the criteria defined above, we found 25 articles with 60 reported estimates of amenity impacts on dependent variables of the three categories "demography", "employment" and "income" (see Appendix, Table 2.A.1). The articles were published between 1981 and 2009 in 17 academic journals mainly in the fields of regional, agricultural, and urban economics. Most studies used county-level data. Some researchers chose other spatial resolutions, namely municipalities (Ali et al., 2007; Ferguson et al., 2007; Gottlieb, 1995; Lundgren, 2009), *Bureau of Economic Analysis Economic Areas* (Greenwood and Hunt, 1989), *State Economic Areas* (Williams, 1981), *Standard Metropolitan Statistical Area* (SMSA) census units (Porell, 1982) and census tracts (Boarnet et al., 2005). The spatial coverage ranges from several states, counties or communities (e.g. Booth, 1999; Duffy-Deno, 1997a, 1997b, 1998; Lewis et al., 2002, 2003; Lundgren, 2009) to the entire (or the entire rural) U.S. (e.g. Clark and Hunter,

[7] HP studies from outside the U.S. use data from Great Britain (Cheshire and Sheppard, 1995; Garrod and Willis, 1992), the Netherlands (Luttik, 2000), Finland (Tyrväinen, 1997; Tyrväinen and Miettinen, 2000), Australia (Tapsuwan et al., 2009), and South Korea (Lee and Linneman, 1998). Exceptions in the field of the U.S.-dominated migration and regional economic studies are papers from Canada (Ali et al., 2007; Ferguson et al., 2007), Great Britain (Park et al., 2009) and Sweden (Lundgren, 2009).

1992; Deller et al., 2001; McGranahan, 2008), Canada (Ali et al., 2007; Ferguson et al., 2007), and England (Park et al., 2009). The majority of the studies employ regional economic system-of-equations models. Three studies (Clark and Hunter, 1992; Ferguson et al., 2007; Porell, 1982) employ single-equation migration models with migration flows as the sole dependent variable. Nine articles used spatial econometric techniques[8] (see Appendix, Table 2.A.1).

The amenity measures in our sample are usually defined as proportions of a certain land-use category relative to the total land surface. Many studies use the proportion of land governed by state or federal agencies, such as the National Park Service (NPS) or the U.S. Forest Service (USFS) as their amenity variable (e.g. Duffy-Deno, 1997a, 1997b, 1998; Poudyal et al., 2008). Others use land-use categories such as wilderness land, conservation land, or forest land (e.g. Ali et al., 2007; Booth, 1999; Ferguson et al., 2007; Lundgren, 2009; McGranahan, 2008; McGranahan and Wojan, 2007; Nzaku and Bukenya, 2005; Park et al., 2009; Poudyal et al., 2008). Such measures are not uniformly defined and reported categories may overlap among studies. A third approach for the construction of amenity measures are amenity indices constructed by means of the principal component method (Deller and Lledo, 2007; Deller et al., 2001; Kim et al., 2005; Porell, 1982). A useful distinction of land amenities is not possible in those studies since aggregates rather than effects of individual amenity attributes are captured. The migration and regional economic studies that we analyzed thus do not allow us to answer questions regarding the effects of specific landscape amenity types.

2.4.2 Reported amenity effects on demography, employment and income

An overview of the landscape amenity effects on different demographic and economic variables is provided in Table 2.1. The dependent variables of the migration and regional economic studies analyzed here can be summarized in three categories: population and migration (occurring in 23 studies), employment (occurring in 17 studies) and

[8] Lewis et al. (2002, 2003) and McGranahan (2008) control for spatial autocorrelation by constructing a spatial weight matrix and testing the null hypothesis of spatial independence using the spatial autocorrelation statistic Moran’s *I* (see e.g. Anselin, 1988; Anselin and Bera, 1998). Ali et al. (2007), Boarnet et al. (2005), Ferguson et al. (2007), Gottlieb (1995), Kim *et al.* (2005) and Nzaku and Bukenya (2005) applied spatial econometric models such as spatial lag or error models, which explicitly incorporate spatial effects (see e.g. Anselin, 1988, 2002; Anselin and Bera, 1998).

income (occurring in 8 studies). Overall, of 60 estimated amenity effects[9] on these dependent variables, 21 were positive and significant. 2 negative effects were found, and the remaining 37 coefficient estimates were non-significant. The highest proportion of positive and significant coefficient estimates was found for effects on variables of the category "population and migration" where 10 out of 26 coefficients were significant and positive while 2 coefficients were significant and negative. Evidence for amenity effects on income is scarce. There were only 11 reported income effects estimated in 8 different studies. 2 out of the 4 significant estimates were obtained for specific types of income (wages and transfers) rather than for total per capita income. Moreover, the significant estimates stem from only three studies (Booth, 1999; Deller and Lledo, 2007; Rasker, 2006). Therefore, it is not possible to make any general statements regarding the impact of landscape amenities on regional income based on empirical studies. Finally, the evidence suggesting an amenity impact on employment is limited. 7 out of 23 coefficient estimates were positive and significant; the remaining 16 estimates were insignificant. The conclusion that can be drawn from the 25 analyzed articles is that population growth and net migration tend to be higher in high-amenity regions. However, the effect on employment change is less well established, while the impact on income change remains unclear.

[9] Since some of the amenity coefficients estimated stem from different equations of the same system-of-equations model, the 60 coefficients are not completely independent.

Table 2.1

Reported effects of amenity, economic opportunity, and fiscal variables on population, employment, and income: frequencies.[a]

Effects on	Amenity effects			Effects of high wages/income			Effects of low unemployment			Effects of low taxes		
	No. obs.[b]	Sig.[c]	Neg. sig.[d]	No. obs.	Sig.	Neg. sig.	No. obs.	Sig.	Neg. sig.	No. obs.	Sig.	Neg. sig.
Population	12	5	2	3	2	1	3	0	2	8	4	0
Migration	14	5	0	12	2	2	7	0	0	4	2	1
Sum	26	10	2	15	4	3	10	0	2	12	6	1
Employment (E.)	12	5	0	7	1	3	6	2	1	6	3	0
E. in the resource sector	4	0	0	3	0	1	3	0	0	4	1	0
E. in other specified sect.	7	2	0	4	0	2	3	0	3	5	1	0
Sum	23	7	0	14	1	6	12	2	4	15	5	0
Income (per capita)	7	2	0	4	0	4	3	3	0	6	2	1
Other income variable	4	2	0	0	0	0	1	0	0	0	0	0
Sum	11	4	0	4	0	4	4	3	0	6	2	1
TOTAL	60	21	2	33	5	13	26	5	6	33	13	2
in %	100	35.0	3.3	100	15.2	39.4	100	19.2	23.1	100	39.4	6.1

[a] The sample is given in Appendix 2.A.1
[b] Number of estimates containing the respective dependent and independent variable.
[c] Number of estimates with coefficients that are positive and significant on the 5% level (see Appendix 2.A.1).
[d] Number of estimates that are negative and significant on the 5% level (see Appendix 2.A.1).

How important are these amenity effects compared with other drivers of economic change? For this comparison, we also report effects of the two most common lagged economic opportunity variables – (wage-)income and unemployment – and a fiscal variable – tax burden – in Table 2.1[11]. In our study sample, high wages and incomes in the past did not induce a positive demographic and economic development. Only 5 out of the 33 estimated coefficients were positive, while 13 were even negative and significant. Also, low unemployment in the past did not explain future growth. However, 6 out of 12 estimates suggest that low local tax rates attracted people, while the effect on employment and income seems limited. Overall, these findings tend to support the equilibrium view (see section 2.2.1) since the evidence for disequilibrium forces is limited, while amenities seem to play a significant role and partly compensate lower wages (e.g. Nzaku and Bukenya, 2005). However, these findings are not uniform; some studies found that economic opportunity variables explain migration better than amenity variables (e.g. Park et al., 2009). Greenwood and Hunt (1989, p. 2) argue that "if employment is growing most rapidly in amenity rich areas, and if employment change is not included as an explanatory variable in the migration equation, then the importance of job opportunities will in part be reflected in the coefficients associated with the amenities." In fact, only ten studies in our sample used employment growth as an independent variable in their population equations. Eight of them (Clark and Hunter, 1992; Deller and Lledo, 2007; Greenwood and Hunt, 1989[12]; Lewis et al., 2002, 2003; McGranahan, 2008; McGranahan and Wojan, 2007; Williams, 1981) conclude that high employment growth significantly promoted population change or net migration. In addition, Porell (1982, p. 156) finds that "whereas in long-run equilibrium attractive QOL [quality of life] should be compensated by less attractive economic incentives, several SMSA's […] offered attractive economic incentives in addition to attractive QOL." Moreover, most of these studies did not control for housing prices, which might cause biases since amenities may capitalize not only in wages but also in

[11] We compare the frequency of significant effects of amenity and economic variables rather than reporting elasticities for two reasons: (1) in 13 studies, no variable means are reported which makes it impossible to calculate elasticities at the sample mean. (2) Due to the substantial heterogeneity in dependent and independent variables a comparison of elasticities of amenities and economic variables is problematic (see section 2.4.1).

[12] Greenwood and Hunt (1989) used workforce data. This may partly explain the high relative importance of job variables in their findings. Moreover, they only considered the direct effects of amenities and jobs on net-migration. However, they remark that amenity-rich places may attract migrants indirectly through job growth if amenities are capitalized into wages and lower wages attract firms.

rents (Roback, 1982, 1988). Hailu and Rosenberger (2004) and Poudyal et al. (2008) use median housing values in their model and found that low housing values were not positively associated with subsequent population growth.

Finally, it must be emphasized that the amenity effects reported in Table 2.1 are direct or total effects.[13] System-of-equations models estimated in their structural form allow partitioning of this effect in principle into a direct and an indirect effect (see e.g. Duffy-Deno, 1997b, 1998; Lewis et al., 2002, 2003; McGranahan, 2008; McGranahan and Wojan, 2007). This approach yields a more distinct insight into the complex relationships between the endogenous variables. If reduced form estimates for example display significant amenity effects on job growth, structural form estimates provide additional information on whether the amenity effects are direct (e.g. by fostering amenity-based leisure industry) or indirect (by attracting skilled workers). A concrete example is given in the carefully conducted study by Lewis et al. (2002) who find that in the U.S. Northern Forest region the conservation land share had a positive direct effect on net migration, whereas net migration positively influenced employment at the end of period. Therefore, the amenity variable had a direct effect on net migration as well as an indirect effect on employment.

2.4.3 Further findings

Some of the 25 studies focus on the commonly expressed concern that fostering natural preserves and wilderness areas might crowd out resource-sector employment, such as employment in the manufacturing of wood products, and harm the economy through lowering total employment, or replacing jobs in the resource-based sector with low-wage service jobs. Duffy-Deno (1998) finds that two types of land-use restrictions, the ownership of land by the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM), had a negative impact on resource employment while there was no evidence of such an effect for federal wilderness. Duffy-Deno (1997a) and Lewis et al. (2002) find no evidence for the crowding-out hypothesis. Moreover, Lewis et al. (2003) and Rasker (2006) could not reject the hypothesis that no negative wage / in-

[13] If both direct and total effects were calculated in a study, we report the direct effects in Appendix 2.A and Table 2.1.

come effects result from preservation lands. Extensive evidence and a rationale against the crowding-out theory are provided in Power and Barrett (2001).

Another object of research is the determinants of an individual's demand for landscape amenities. Personal characteristics are an important migration determinant alongside with economic, fiscal and amenity conditions in the sending and receiving locations (Greenwood, 1985). Clark and Hunter (1992) analyze the relative importance of amenity, fiscal and economic opportunity variables in a life-cycle migration framework. They estimate a net-migration equation for five-year age cohorts of white males. The landscape amenity variable in their model (share of land in state parks, forests, water-use areas, trails, and other recreational areas) is found to be a positive and significant determinant of net migration only for age cohorts from 40 upwards. The authors obtain similar results for all other natural amenities (climate and coastal variables): they find significant amenity effects for middle-aged and older males, while younger males tended to be attracted by labor-market features and migrate to city centers. The results of a recent retiree migration study using a particularly comprehensive set of landscape amenity variables (Poudyal et al., 2008) confirm the relatively high importance of landscape amenities for retiree's locational choice. In a further recent article, Ferguson et al. (2007) estimate a comparable model using data from Canadian communities and a broadly defined amenity group containing landscape, climate and nonnatural amenities. They conclude that in rural areas economic factors rather explain population growth than amenities do. However, the influence of amenities as locational factor is rising with the age of the migrants. In urban areas amenities and economic factors were of similar importance as migration determinants.

2.5 Empirical evidence from hedonic property value models

2.5.1 Study sample and definition of amenity groups

Based on the definitions and selection criteria introduced, we found 46 relevant articles with 53 independent hedonic regressions (see Appendix, Table 2.A.2).[14] These articles

[14] Geoghegan et al. (2003), Nelson (1986), Nicholls and Crompton (2005), and Thorsnes (2002) estimated several models with independent sub-samples.

were published between 1986 and 2009 in 26 academic journals mainly in the fields of environmental and resource, agricultural, and real-estate economics. In the present study sample, there are often several model specifications reported for individual independent regressions. Moreover, the reported models may contain one or several amenity coefficients, and the definition of the amenity variables is never exactly the same in any two studies. To assess the reported evidence we distinguish the characteristics "regression", "specification", "amenity group", and "amenity coefficient". Hence, the reported amenity coefficients can be written b_{ijkl}, where i indicates the regression, j denotes the particular specification of the regression, k is the amenity group and l indicates the individual reported amenity coefficient.

We distinguish six landscape amenity groups: open space ("open space"), forest, trees and wooded areas ("forest"), wilderness, conservation areas and preserved land ("preserve"), wetlands ("wetland"), land in agricultural use ("agriculture") and land cover diversity or richness ("diversity"). These amenity variables appear as explanatory variables in the hedonic property value models in addition to other exogenous variables such as property attributes, neighborhood, and socio-economic variables. Treating the amenities as exogenous and time invariant implies that changes in amenities are assumed to be small at the time scales relevant to hedonic price formation (see Riddel, 2001). The amenity measures occur as proximity variables (e.g. distance to nearest forested area), proportion measures (e.g. percentage of land classified as open space within a given distance from the property) or as binary variables (e.g. vicinity of preserved land). Most studies in the sample deal with forest and open space amenities solely or with a combination of different landscape amenity types.

2.5.2 Reported amenity effects on property values

As mentioned above, many hedonic property value studies employ several alternative definitions of an amenity (e.g. percentage of open space within a radius of 200 and within a radius of 500 m from the property) or estimate different specifications using the same dataset. For a first quantitative assessment of the reported amenity effects we pool the reported coefficients for each amenity group k and each specification j within regressions i, yielding a sample of n= 84 observations for b_{ik}. We define b_{ik} as a *significant* reported amenity effect if at least 50% of the pooled amenity coefficients were positive and significant at the 5% level. In addition, we define b_{ik} as *robust* if all pooled amenity coefficients were positive and significant. Table 2.2 reports the number of observations that were significant and robust, respectively, for each amenity group. The underlying sample is presented in Appendix 2.A.2.

For each of the amenities "open space", "forest" and "wetland" the reported amenity effects were significant in about half of the observations. The highest proportion of significant amenity effects were found for "preserve" (9 out of 11 observations) and for "diversity" (6 out of 8 observations).

Table 2.2

Frequency of significant and robust reported amenity effects in the HP studies.[a]

	Landscape amenity variables: frequencies[b]						
	Open space	Forest	Preserve	Wetland	Agriculture	Diversity	Sum
Sample size	30	20	11	6	9	8	84
Effect significant	15	9	9	3	2	6	44
Effect robust	7	3	4	1	0	4	19

[a] The sample is given in Appendix, Table 2.A.2.
[b] See section 2.5.1 for definitions of the variables.

Of 9 observations for agricultural land use ("agriculture") only 2 were positive and significant. The agricultural land-use variables in the regressions were cropland/farmland (Bockstael, 1996; Hardie et al., 2007; Irwin 2002; Johnston et al., 2001; Kuminoff, 2009; Ready and Abdalla, 2005), pasture (Bockstael, 1996) and unspecified agricultural land (Neumann et al., 2009; Paterson and Boyle, 2002; Smith et al. 2002). The variables were specified as percentage of a neighborhood area or within a certain radius around the property (Bockstael, 1996; Hardie et al., 2007; Irwin, 2002; Paterson and Boyle, 2002; Kuminoff, 2009), as zone or adjacency dummy (Johnston et al., 2001; Ready and Abdalla, 2005; Smith et al. 2002), or as a distance measure (Johnston et al.,. 2001; Neumann et al., 2009; Smith et al. 2002). A positive and significant impact on property prices was found for pastureland (Bockstael, 1996) and in one case – depending on the distance – for cropland (Kuminoff, 2009). The remaining HP studies found non-significant or even negatively significant relationships between cropland/agricultural land and property prices. Johnston et al. (2001) argue that amenity effects of agricultural open space may – depending on the type of farms – partly be overcompensated by disamenity effects of agricultural production such as odors, water pollution and noise (see also Palmquist et al., 1997). In a carefully conducted study, Ready and Abdalla (2005) included a variable for animal facilities in order to reduce omitted variable bias in the coefficients of the agricultural land-use variables. Their results suggest that residents reveal a significant and positive willingness to pay for agricultural land within a radius of 400 to 1600 m from the property, while the percentage of agricultural land within a radius of 400 m was not significant.

While forests provide the basis for timber production, they may also provide amenity values in terms of recreational, ecological and aesthetic benefits. The coefficients for forest measures were quite variable. Studies finding nonsignificant or negative effects tended to use global measures of forest presence or distance or did not control for forest and forest management types (Benefield, 2009; Bockstael, 1996; Hardie et al., 2007; Irwin, 2002; Paterson and Boyle, 2002; Sander and Polasky, 2009; Smith et al., 2002; Tyrväinen, 1997; White and Leefers, 2007). Positive effects were found for urban forests (Luttik, 2000; Mansfield et al., 2005; Netusil, 2005; Poudyal et al., 2009b; Tyrväinen and Miettinen, 2000) or forest preserves (Thorsnes, 2002). The strength and direction of forest effects on property prices seem to depend on the type of forest and forest management. A British HP study (Garrod and Willis, 1992) found that broadleaved woodland had a small but significantly positive impact on property prices, while production oriented conifers exhibited a significant negative influence. Kim and Johnson (2002) stand out by controlling for attributes related to industrial forest use such as clear-cut sites and even-aged management. Their findings suggest that recreational and aesthetic amenity values provided by forests can be offset by production oriented management. A particularly detailed study is also Cho et al. (2008) who examine how the amenity values of different forest types, patterns and edges vary according to the degree of urbanization. Moreover, in a very recent paper Poudyal et al. (2010) construct a sophisticated measure for forested landscape in a viewshed and find a positive impact of forest view on property prices.

The frequency of robust amenity effects was low, ranging from 0 out of 9 (for "agriculture") and 3 out of 20 (for "forest") to 4 out of 11 (for "preserve") and 4 out of 8 (for "diversity"). This confirms that the evidence in the literature is limited. To a certain extent this may truly reflect weak or absent effects. However, the results also depend on modeling approaches, definitions and measurement of amenities. One important point here is the choice of the baseline land-use variable in regressions. The consequence of this choice for the estimated amenity effects is rarely addressed[15], which sets limits to comparisons across studies.

Using the same sample of 84 observations and the same definition of a significant coefficient, we also analyzed the determinants of significant amenity effects in a binary regression framework (see e.g. Jeppesen et al., 2002, p. 26). The explanatory variables in the model are the year of publication, a set of dummy variables for the different amenity types (using open space as the reference), and dummy variables coding for: local (data from one county) *vs.* regional scale of the study; rural (not including urban or sub-urban parts) *vs.* non-rural study areas; whether other natural (non-landscape) amenities were included in the specification; and whether the authors had made efforts to control for spatial autocorrelation. Of the amenity dummies, only agriculture was weakly significant in the binary regression ($\beta = -1.83$; $p = 0.07$). Studies conducted at a local scale were less likely to report significant amenity effects than studies conducted at a regional scale ($\beta = -1.65$; $p = 0.10$) and the probability of significant amenity effects was lower in rural than in (sub-)urban areas ($\beta = -1.70$; $p = 0.09$). The remaining study characteristics were non-significant.[16]

2.6 Discussion

A clear finding is that evidence in the compiled literature strongly concentrates on the U.S.. Due to different economic, social and cultural environments the role of amenities in other developed countries may be different from that in the U.S. For example, considering the sizable budget involved in European agri-environmental policies[17], a better

[15] An exception is the article of Ready and Abdalla (2005) who use zoning and broad land-use categories in their HP regression and provide results for both industrial and residential baseline land-uses.
[16] The dataset and statistical output are available from the authors on request.
[17] The European Union support for rural development for the period of 2007 to 2013 amounts to 88 billion Euros (http://ec.europa.eu/budget/documents/multiannual_framework_en.htm, accessed 09/13/2007). Of the 126-billion-Euro European Union budget for 2007, 34% are allocated to the management of natural resources (http://ec.europa.eu/budget/budget_ detail/current_year_en.htm, accessed 09/13/2007).

understanding of the role of European landscape amenities is an important objective to which empirical research can contribute.

The available regional economic and migration studies suggest that amenity-rich regions tended to grow faster in terms of population than other areas. Significant and positive amenity effects were comparable in frequency with those of a low tax burden. Several studies suggest that the conservation of natural amenities for recreational uses did not harm the local economy through crowding out resource-based employment. However, the overall impact on economic development remains unclear as the evidence on the link between amenities and employment or income is largely inconsistent. The notion of landscape amenities as a development tool therefore still lacks unambiguous empirical support. Future studies should use enhanced landscape and land-use measures. Amenity indices (e.g. McGranahan, 1999) are a reasonable instrument to capture global landscape quality. However, the underlying indicators should cover the full range of landscape and land-use attributes. New spatial analysis tools in connection with spatial econometric methods have the potential to overcome important data limitations of many earlier studies. Furthermore, attention should be paid to life-cycle effects and the personal characteristics of migrants attracted by amenities (see e.g. Clark and Hunter, 1992; Ferguson et al., 2007; Poudyal et al., 2008). Key questions are: (1) which individuals are attracted by which amenities? and (2) what are the consequences of the socioeconomic characteristics of these individuals with regard to the regional economic development? Approaches relying on household-level panel data and survey-based evidence could provide answers (e.g. Huffman and Feridhanusetyawan, 2007).

The evidence from hedonic pricing studies complements the insights from regional economic and migration models. Our analysis suggests that nature reserves and land cover diversity mostly and open space and forest frequently increase the prices of neighboring properties. By contrast, evidence of positive valuations of agricultural land by neighboring residents is scarce, perhaps because most studies fail to control for the type of agricultural production, while disamenities from intensive production might offset potential landscape amenity effects (Bergstrom and Ready, 2009). Moreover, positive amenity effects are more frequent in urban or suburban than in rural areas where landscape amenities tend to be less scarce. The limited consistency of the results across hedonic pricing studies parallels the conclusions in reviews on hedonic values of air quality (Chay and Greenstone, 2005) and light-rail access (Redfearn, 2009) and may reflect a diversity of amenity definitions and model specifications (see 5.1). Regardless of the reasons for the limited consistency, the findings suggest that the potential for benefit transfer is limited. Nevertheless, the results show that landscape amenities are partly capitalized in rents. However, utility gains through higher amenity endowments may also be reflected in wages (Roback, 1982, 1988), which calls for multi-market hedonic models (e.g. Hand et al., 2008). A better understanding of this capitalization process may also help to better understand the relationship between amenities and employment, since the latter depends on wage levels.

An important further source of evidence on how landscape amenities affect location decisions is surveys. Economic survey research has focused on the monetary valuation of land-use alternatives for use in cost benefit analysis. Unfortunately, due to uncertainties of the survey process, that evidence remains inconclusive in many ways (Bergstrom and Ready, 2009). Furthermore, the focus on average or total willingness to pay in that literature is also somewhat disconnected from the needs of stakeholders and policy makers in land-use planning (Banzhaf, 2010, p. 600). However, a variety of other survey, focus-group and workshop approaches have also contributed to the understanding of people's landscape needs and preferences regarding both public land use (e.g. Banzhaf, 2010; Kline and Wichelns, 1996) and private location (e.g. Milburn et al., 2010) decisions (for a review of various approaches see e.g. Matsuoka and Kaplan, 2008).

Survey research can identify variations in preferences among settings, neighborhoods and segments of the population, which are difficult to identify in standard hedonic pricing and regional economic models. To illustrate, one large survey in three rapidly growing Michigan counties finds that natural and openness features were important for only a minority of home buyers (Vogt and Marans, 2004). Importance was higher for higher income and older individuals and for those living in rural townships. In contrast, the same features ranked at the top in a series of focus groups of residents in neighborhoods with much open space. In political decisions, peoples' reasons and preferences for protection appear to depend on the reference land use: for instance, in the case of non-agricultural land, ecological and environmental values rank at the top, while "agrarian" motives score higher in protecting farmland (see Banzhaf, 2010, p. 594). We suggest that the value of the modeling approaches reviewed in this chapter could be increased by complementary evidence on the underlying decision processes. Evidence about local decision motives could at the same time facilitate judgments about the possibility to transfer study results across regions.

The study by Vogt and Marans (2004) also relates to another issue on which the reviewed evidence is somewhat limited – the fact that the land-based amenities are not always exogenous. The authors find that natural and openness features were rated more highly by homeowners who preferred large lot, auto-oriented neighborhoods, suggesting that these homeowners are attracted by and may at the same time degrade amenities at the urban fringe (Chen et al., 2009). Further side effects of amenity-induced growth, described e.g. by Reeder (1998) and Skelley (2004) who focus on retiree-attraction policies, include congestion, pollution, rising housing prices, and cost of living for the locals. Future research should focus on strategies that involve natural amenities as development tool for rural regions without compromising the goals of sustainable land use. Transport infrastructure planning is likely to play a key role in such strategies. Conversely, environmental policies to *preserve* amenities may be endogenous as well (e.g. Fleming et al., 2009, p. 3), which is perhaps most evident from the relative success of open space referenda in densely populated regions. However, the dynamic interactions of landscape amenities, development and environmental policy are beyond the scope of the reviewed empirical approaches. They remain an important topic for further study using approaches that take political responses to amenity changes into account (Chen et al., 2009; Nelson et al., 2007; Walsh, 2007).

2.7 Conclusion

Empirical work on effects of amenities on property prices, population, employment, and income is useful to understand the increasingly important links between landscape management and economic change. While several studies have surveyed the role of environmental regulations on economic development (e.g. Jeppesen et al., 2002), the present study is among the first to provide a synopsis of the available evidence on the role of land-use-related amenities in local economic change.[18]

We conclude that, in spite of considerable efforts that went into the reviewed empirical research, the evidence on any positive role of landscape amenities for local economic development, or even merely on housing prices, remains limited. On its own, the evidence would hardly suffice as an argument for substantial public spending on landscape amenities. However, this perception contrasts sharply with the evidence from hundreds of voting decisions on open space preservation across the U.S. which show that the citizens are willing to authorize billions of tax dollars for the conservation of landscape amenities (e.g. Kline and Wichelns 1994, Kotchen and Powers 2006, Nelson et al. 2007). The apparent paradox reminds us that the evidence obtained from the analysis of market processes (including location decisions) reflects only one (possibly minor) part of the value of land-use-related externalities. The environmental economic and regional science literature has placed much emphasis on market decisions and relatively little emphasis on the analysis of political decisions. In order to provide useful advice to policy makers, regional and environmental economists' attention should shift towards a fuller consideration and analysis of political preferences and institutions for land-use management. This conclusion parallels findings by Hellerstein et al. (2002) and in the recent report on the valuation of ecosystems and ecosystem services (USEPA 2009) which also emphasizes the role of political deliberation and decision processes. With the traditional emphasis on market behavior, we are missing important information that is relevant for land-use decisions at local to national scales.

[18] In a recent working paper Fleming et al. (2009) collected and analyzed evidence on amenity impacts on rural development. In contrast to the present study they focus on natural rather than just landscape amenities and on articles published between 2001 and 2008.

Appendix

Table 2.A. 1

Survey sample: migration and regional economic studies.[a]

Author(s)	Journal	Dependent variable[b]	L	Model[c]	Independent variables				Autocr.	Estimation[f]
					Amenity[d]	Tax[e]	Wage[e]	Unempl.[e]		
Ali et al., 2007	IRSR	Pop	0	RE	0	--	--	--	1	OLS, SEM / MLE, GWR
Boarnet et al., 2005	PRS	Pop	0	RE / SEQ	1	--	--	--	1	IV
Boarnet et al., 2005	PRS	Empl	0	RE / SEQ	0	--	--	--	1	IV
Booth, 1999	GC	Pop	1	RE	1	--	--	--	0	OLS
Booth, 1999	GC	Empl	1	RE	0	--	--	--	0	OLS
Booth, 1999	GC	Inc	1	RE	0	--	--	--	0	OLS
Booth, 1999	GC	Inc (wage)	1	RE	1	--	--	--	0	OLS
Booth, 1999	GC	Inc (dividend)	1	RE	0	--	--	--	0	OLS
Booth, 1999	GC	Inc (transfer)	1	RE	1	--	--	--	0	OLS
Clark and Hunter, 1992	JRS	NetMig (age>40)	1	MIG / LC	1	1	[-]	0	0	OLS
Clark and Hunter, 1992	JRS	NetMig (age≤40)	1	MIG / LC	0	[-]	[-]	0	0	OLS
Deller and Lledo, 2007	ARER	Pop	0	RE	0	1	--	--	0	BMA
Deller and Lledo, 2007	ARER	Empl	0	RE	1	1	--	--	0	BMA
Deller and Lledo, 2007	ARER	Inc (per capita)	0	RE	1	[-]	[-]	1	0	BMA
Deller et al., 2001	AJAE	Pop	0	RE	1	1	[-]	[-]	0	OLS
Deller et al., 2001	AJAE	Empl	0	RE	1	0	[-]	1	0	OLS
Deller et al., 2001	AJAE	Inc (per capita)	0	RE	0	1	[-]	1	0	OLS
Duffy-Deno, 1997a	GC	Empl (non-resource)	0	RE / SEQ	0	0	[-]	[-]	0	2SLS
Duffy-Deno, 1997a	GC	Empl (resource)	0	RE / SEQ	0	0	0	0	0	2SLS
Duffy-Deno, 1997b	JLR	Pop	1	RE / SEQ	1	0	--	--	0	2SLS

(continued on next page)

(Table 2.A.1, continued)

Author(s)	Journal	Dependent variable[b]	L	Model[c]	Independent variables				Autocr.	Estimation[f]
					Amenity[d]	Tax[e]	Wage[e]	Unempl.[e]		
Duffy-Deno, 1997b	JLR	Empl (non-resource)	1	RE / SEQ	1	0	[-]	[-]	0	2SLS
Duffy-Deno, 1997b	JLR	Empl (resource)	1	RE / SEQ	0	0	[-]	0	0	2SLS
Duffy-Deno, 1998	JRS	Pop	1	RE / SEQ	0	1	--	--	0	2SLS
Duffy-Deno, 1998	JRS	Empl (non-resource)	1	RE / SEQ	0	0	0	[-]	0	2SLS
Duffy-Deno, 1998	JRS	Empl (resource)	1	RE / SEQ	0	1	0	0	0	2SLS
Duffy-Deno, 1998	JRS	Empl	1	RE / SEQ	0	0	0	[-]	0	2SLS
Ferguson et al., 2007	GC	NetMig	1	RE / MIG	0	--	0	--	1	WLS, SEM
Gottlieb, 1995	US	Empl (high-tech)	1	RE / FL	0	--	--	--	1	Tobit / MLE, logit / min chi-square
Greenwood and Hunt, 1989	JUE	NetMig	1	RE / SEQ	0	--	0	0	0	OLS, 2SLS, 3SLS
Hailu and Rosenberger, 2004	ARER	Pop	0	RE / SEQ	[-]	0	--	[-]	0	2SLS
Hailu and Rosenberger, 2004	ARER	Empl	0	RE / SEQ	1	0	--	--	0	2SLS
Kim et al., 2005	GC	Pop	0	RE	0	0	--	--	1	SEM, MLE
Kim et al., 2005	GC	Empl (service)	0	RE	0	0	--	--	1	SEM, MLE
Kim et al., 2005	GC	Inc (per capita)	0	RE	0	0	--	--	1	SEM, MLE
Lewis et al., 2002	LE	Empl	0	RE / SEQ	0	--	--	0	1	3SLS
Lewis et al., 2002	LE	NetMig	1	RE / SEQ	1	--	0	--	1	3SLS
Lewis et al., 2003	GC	Empl	0	RE / SEQ	0	--	--	0	1	3SLS
Lewis et al., 2003	GC	NetMig	1	RE / SEQ	1	--	0	--	1	3SLS
Lewis et al., 2003	GC	Inc (wage per capita)	0	RE / SEQ	0	--	--	0	1	3SLS
Lundgren, 2009	GC	NetMig	1	RE / SEQ	0	0	--	--	0	IV, GMM
Lundgren, 2009	GC	Empl (forest sector)	1	RE / SEQ	0	0	--	--	0	IV, GMM
Lundgren, 2009	GC	Empl (tourism sector)	1	RE / SEQ	0	1	--	--	0	IV, GMM
Lundgren, 2009	GC	Inc (per capita)	0	RE /SEQ	0	0	--	--	0	IV, GMM
McGranahan, 2008	LUP	NetMig	1	RE / SEQ	0	--	1	--	1	3SLS, OLS
McGranahan, 2008	LUP	Empl	0	RE / SEQ	1	--	[-]	--	1	3SLS, OLS

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(Table 2.A.1, continued)

Author(s)	Journal	Dependent variable[b]	L	Model[c]	Independent variables				Autocr.	Estimation[f]
					Amenity[d]	Tax[e]	Wage[e]	Unempl.[e]		
McGranahan and Wojan, 2007	RS	NetMig	0	RE / SEQ	0	--	0	--	0	3SLS, OLS
McGranahan and Wojan, 2007	RS	Empl (total)	0	RE / SEQ	0	--	[-]	--	0	3SLS, OLS
McGranahan and Wojan, 2007	RS	Empl (creative class)	0	RE / SEQ	1	--	0	--	0	3SLS, OLS
Nzaku and Bukenya, 2005	RURDS	Pop	0	RE / SEQ	[-]	--	1	0	1	SLM, MLE
Nzaku and Bukenya, 2005	RURDS	Empl	0	RE / SEQ	--	1	0	1	1	SLM, MLE
Nzaku and Bukenya, 2005	RURDS	Inc (per capita)	0	RE / SEQ	--	0	[-]	1	1	SLM, MLE
Park et al., 2009	EDS	Pop	0	RE / SEQ	1	0	1	--	0	OLS
Park et al., 2009	EDS	Empl	0	RE / SEQ	0	1	0	--	0	OLS
Park et al., 2009	EDS	Inc	0	RE / SEQ	0	1	[-]	--	0	OLS
Porell, 1982	JRS	InMig	1	MIG / GR	1	--	1	0	0	OLS
Porell, 1982	JRS	OutMig	1	MIG / GR	0	--	0	0	0	OLS
Poudyal et al., 2008	EE	NetMig (Retirees)	1	RE / MIG	1	1	--	--	0	3SLS
Rasker, 2006	SNR	Inc (per capita)	0	RE	1	--	--	--	0	OLS
Williams, 1981	RS	InMig	1	MIG / SEQ	0	--	0	0	0	3SLS, OLS
Williams, 1981	RS	OutMig	1	MIG / SEQ	0	--	0	0	0	3SLS, OLS
Williams, 1981	RS	Empl	0	MIG / SEQ	1	--	1	0	0	3SLS, OLS

[a] Column headings: L=levels specification (1=levels, 0=flow), Tax=effect of low local tax rates, Wage=effect of high average wage / income, Unempl.=effect of low local unemployment, Autocr.=test for spatial autocorrelation or spatial econometric model (1=yes, 0=no).
[b] Pop=population, Empl=employment, Inc=income, NetMig=net migration, InMig=in-migration, OutMig=out-migration.
[c] RE=regional economic / urban economic, MIG=migration, LC=life-cycle, SEQ=system of equations, FL=firm location decision, GR=gravity.
[d] 1=at least 50% of amenity coefficients in model are positive and significant on the 5% level, 0=non-significant, [-]=negative and significant.
[e] 1=positive and significant on the 5% level, 0=non-significant, [-]=negative and significant.
[f] BMA=Bayesian modeling average, GMM=general method of moments, GWR= geographically weighted regression, IV=instrumental variables technique (spatially explicit), MLE=maximum likelihood estimator, OLS=ordinary least squares, SEM=spatial error model, SLM=spatial lag model, 2SLS=two stage least squares, 3SLS=three stage least squares, WLS=weighted least squares.

Table 2.A.2

Survey sample: hedonic pricing estimates.

Author(s)	Journal	Amenity[a]	Significant and positive effect[b]	Robust effect[b]
Acharya and Bennet, 2001	JREFE	open space	1	1
Acharya and Bennet, 2001	JREFE	diversity	0	0
Anderson and West, 2006	RSUE	open space	1	0
Anderson and West, 2006	RSUE	preserve	1	0
Asabere and Huffman, 2009	JREFE	open space	1	1
Bastian et al., 2002	EE	diversity	1	1
Bastian et al., 2002	EE	preserve	0	0
Benefield, 2009	PM	forest	0	0
Bockstael, 1996	AJAE	preserve	1	1
Bockstael, 1996	AJAE	forest	0	0
Bockstael, 1996	AJAE	agriculture	1	0
Bohlen and Lewis, 2009	JEM	open space	1	0
Bohlen and Lewis, 2009	JEM	diversity	1	0
Cheshire and Sheppard, 1995	EC	open space	1	0
Cho et al., 2006	JARE	open space	1	1
Cho et al., 2008	EE	forest	1	0
Cho et al., 2008	EE	diversity	1	1
Cho et al., 2009	EE	preserve	1	1
Doss and Taff, 1996	JARE	wetland	1	0
Fisher et al, 2009	RealEE	open space	1	1
Garrod and Willis, 1992	ERE	forest	1	0
Geoghegan et al., 1997	EE	open space	0	0
Geoghegan et al., 1997	EE	diversity	0	0
Geoghegan, 2002	LUP	open space	1	0
Geoghegan et al., 2003	ARER	open space	0	0
Geoghegan et al., 2003	ARER	open space	0	0
Geoghegan et al., 2003	ARER	open space	1	0
Hand et al., 2008	LE	preserve	1	1
Hardie et al., 2007	LE	wetland	0	0
Hardie et al., 2007	LE	forest	0	0
Hardie et al., 2007	LE	agriculture	0	0
Irwin and Bockstael, 2001	AJAE	open space	1	0
Irwin and Bockstael, 2001	AJAE	preserve	1	1
Irwin, 2002	LE	agriculture	0	0
Irwin, 2002	LE	forest	0	0
Irwin, 2002	LE	preserve	1	0
Irwin, 2002	LE	open space	1	0
Johnston et al., 2001	GC	agriculture	0	0
Johnston et al., 2001	GC	open space	0	0
Johnston et al., 2001	GC	wetland	0	0

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(Table 2.A.2, continued)

Author(s)	Journal	Amenity[a]	Significant and positive effect[b]	Robust effect[b]
Kim and Johnson, 2002	SNR	forest	0	0
Kuminoff, 2009	JARE	agriculture	1	0
Lee and Linneman, 1998	REE	open space	0	0
Legget and Bockstael, 2000	JEEM	open space	0	0
Luttik, 2000	LUPla	open space	0	0
Luttik, 2000	LUPla	forest	1	1
Luttik, 2000	LUPla	diversity	1	1
Lutzenhiser and Netusil, 2001	CEP	preserve	1	0
Mahan et al., 2000	LE	wetland	1	1
Mansfield et al., 2005	JFE	forest	1	0
Munroe, 2007	EPB	open space	0	0
Nelson, 1986	JAPA	open space	1	1
Nelson, 1986	JAPA	open space	0	0
Netusil, 2005	LE	open space	1	1
Netusil, 2005	LE	forest	1	0
Netusil, 2005	LE	wetland	0	0
Netusil, 2005	LE	preserve	0	0
Neumann et al., 2009	LUP	diversity	1	0
Neumann et al., 2009	LUP	agriculture	0	0
Neumann et al., 2009	LUP	preserve	1	0
Nicholls and Crompton, 2005	JLR	open space	0	0
Nicholls and Crompton, 2005	JLR	open space	0	0
Nicholls and Crompton, 2005	JLR	open space	0	0
Paterson and Boyle, 2002	LE	agriculture	0	0
Paterson and Boyle, 2002	LE	forest	0	0
Poudyal et al., 2009b	FPE	forest	1	1
Poudyal et al., 2009b	FPE	diversity	1	1
Ready and Abdalla, 2005	AJAE	open space	1	0
Ready and Abdalla, 2005	AJAE	agriculture	0	0
Sander and Polasky, 2009	LUP	forest	0	0
Sander and Polasky, 2009	LUP	open space	1	1
Shultz and King, 2001	JREFE	preserve	1	0
Shultz and King, 2001	JREFE	open space	0	0
Smith et al., 2002	REE	open space	0	0
Smith et al., 2002	REE	forest	0	0
Smith et al., 2002	REE	agriculture	0	0
Tapsuwan et al., 2009	AJARE	wetland	1	0
Thorsnes, 2002	LE	forest	1	0
Thorsnes, 2002	LE	forest	1	0
Thorsnes, 2002	LE	forest	0	0
Tyrväinen, 1997	LUPla	forest	0	0

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(Table 2.A.2, continued)

Author(s)	Journal	Amenity[a]	Significant and positive effect[b]	Robust effect[b]
Tyrväinen and Miettinen, 2000	JEEM	forest	1	1
White and Leefers, 2007	SNR	forest	0	0
White and Leefers, 2007	SNR	open space	0	0

[a] For definitions see section 2.5.1.
[b] For definitions see section 2.5.2.

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The Role of Landscape Amenities in Regional Development: Evidence from Swiss Municipality Data

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Chapter 3

The Role of Landscape Amenities in Regional Development: Evidence from Swiss Municipality Data

3.1 Introduction

With increasing environmental scarcities, policies to manage landscape amenities receive increasing interest among policy makers and the public. Landscape amenities are seen as a factor that contributes to the quality of life for local residents and may also benefit economic development by attracting tourists as well as industries depending on highly qualified workers. The increasing interest is evident, for instance, from a multitude of open space referenda and related debates about urban development in the U.S. and elsewhere (Nelson et al., 2007), from hedonic pricing studies that include amenity variables (Irwin, 2002; Neumann et al., 2009), or from new agricultural policy programs specifically designed to remunerate farmers for managing landscape amenities (e.g. Hajkowicz et al., 2009; Hanley et al., 2007; Kline and Wichelns, 1996).

In the U.S. a growing number of studies is trying to identify the links between landscape amenities and regional development measured by change in population, employment and other development variables (e.g. Deller et al., 2001; Duffy-Deno, 1998; Lewis et al., 2002; McGranahan, 2008). While there is an extensive literature on landscape values using revealed (e.g. Mollard et al., 2007; Tyrväinen and Miettinen, 2000) and especially stated preference approaches (e.g. Brouwer and Slangen, 1998; Sayadi et al., 2009) European evidence on the impact of landscape quality on regional development is scarce and mainly limited to sectoral case studies on regional economic impacts and value added of parks and nature-based tourism (e.g. Getzner and Jungmeier, 2002; Mayer et al., 2010).

European applications are of interest for several reasons. European regions are composed of rich and diverse pattern of cultural landscapes which has evolved over hundreds of years, providing identity to local populations (e.g. Antrop, 2005) which remain less footloose than in the U.S. (Cheshire and Magrini, 2009). Environmental amenities and rural development are an increasingly important motive for agricultural support programs in the European Union and its member countries (e.g. Acs et al., 2010). Finally, although the value of landscape resources is increasingly recognized, many of these amenities are under pressure from urbanization and modern agricultural land use. Empirical work on the links between amenities and local development is therefore relevant for a variety of active policy fields related to local development and land use including agricultural policies, regional policies, and spatial planning policies.

In this chapter, we apply the classic simultaneous equations model by Carlino and Mills (1987) to data from 2467 municipalities in Switzerland to examine how landscape amenities and related policies affected regional development along with other fiscal, demographic and infrastructure variables during the period from 1995 to 2005. Our focus is on natural and managed landscape amenities rather than on built amenities like city parks, mountain railways or other tourism-related infrastructure. While the fiscal and demographic variables are based on standard sources, the landscape variables were constructed, using a geographic information system, based on the highly disaggregated land cover data which are available for Switzerland.

The questions we address are: (1) how did the traditional locational factors affect population and employment? Here, we consider initial conditions regarding population and employment; income; taxes; demographic composition; economic structure (employment in different sectors); and distance to major cities and regional centers. (2) How did the abundance of amenities affect population and employment? Here, we consider the abundance of open space; the abundance of a set of aesthetically valuable landscape features; distance to major lakes; and accessibility of the landscape for recreation (measured by density of hiking trails).

In addition to the questions about the role of landscape features, we also address two questions about the role of existing land-use related policies: (3) how did the income transfers to farmers and the more targeted direct payments of the Swiss agricultural policy affect local economic change?; and (4) how did regulations related to the federal inventories of national heritage landscapes and national heritage townscapes affect local development?

An advantage of using Switzerland as a study region is its high diversity of local conditions which provides the necessary variation for statistically isolating effects. Due to similarities of its landscapes with those of other countries at least in central Europe, the study should be of interest beyond the Swiss setting. Even the policy variables we examine have parallels in other European countries. For instance, the national heritage landscapes and townscapes parallel nationally significant nature parks and historic towns elsewhere. A particularity of the Swiss setting is the high degree of local autonomy of the Swiss communities in fiscal and land use planning policies. However, unlike the fiscal conditions which we control in the model, the considered amenity variables are largely exogenous. They are consequence of the natural setting or, in the case of the policy variables we examine, determined by the federal government.

This chapter is composed of seven sections. The next section reviews the literature on the role of amenities in local development. Section 3.3 presents the conceptual framework for the empirical study. Section 3.4 describes the empirical model and the data. Sections 3.5 and 3.6 provide the results and discussion. A final section presents conclusions and directions for further research.

3.2 Landscape amenities and regional development

3.2.1 Effects of landscapes

A growing literature on amenity-induced regional development suggests that attractive landscapes have the potential to be a non-negligible driver of regional and local change by attracting in-migrants (e.g. Poudyal et al., 2008), entrepreneurs (e.g. Beyers and Lindahl, 1996), tourists and recreation industries (e.g. Vanslembrouck et al., 2005), and by providing ecosystem services which are valued by locals (e.g. Pimentel et al., 1995). The prevailing framework for these studies is the regional adjustment model (Steinnes and Fisher, 1974) which was introduced by regional scientists and urban economists.

Steinnes and Fisher (1974) proposed a simple partial adjustment model of intraurban location allowing for simultaneous determination of the distribution of firms and households. Carlino and Mills (1987) developed a similar model and used it to analyze the determinants of employment and population growth in US counties. The early studies on regional development concentrated on the causal relations of employment and population growth (cf. Muth, 1971) while exogenous variables were often restricted to demographic, labor market and classical locational variables such as tax burden and accessibility. Location-specific amenities were accounted for by including simple but limited proxies such as regional dummies (e.g. Carlino and Mills, 1987) or climate variables and coastal dummies (e.g. Clark and Murphy, 1996).

Increasingly, this approach is used by researchers interested in the regional economic effects of amenities. Since the 1990s, GIS software and geo-referenced data allow sophisticated analyses using more complete measures of landscape amenities. Table 3.1 provides an overview of regional adjustment studies on the role of landscape in regional development. Fourteen studies were identified; twelve of them use U.S. data.[1] The spatial coverage ranges from regions (e.g. Duffy-Deno, 1997a; Lundgren, 2009) to the entire (rural) U.S. (Deller et al., 2001; McGranahan, 2008). The unit of observation is usually a county or a municipality (Lundgren, 2009). An exception is Boarnet et al. (2005) who use a higher spatial resolution (census tracts) and a smaller spatial coverage (one county).

The broad amenity-related land-use categories employed in these studies comprise (1) agricultural land (Boarnet et al., 2005) or specific agricultural land-uses such as cropland (McGranahan, 2008; Nzaku and Bukenya, 2005), pasture and preserved agricultural land (Nzaku and Bukenya, 2005), (2) forest land (Duffy-Deno, 1997a, 1997b, 1998; Hailu and Rosenberger, 2004; Lewis et al., 2002, 2003; McGranahan, 2008; Nzaku and Bukenya, 2005), (3) public wilderness/preserved land including national and state parks (Duffy-Deno, 1997a, 1997b, 1998; Lewis et al., 2002, 2003; Lundgren, 2009), (4) other public lands such as county land and land governed by the

[1] Two recent studies use data from Sweden (Lundgren, 2009) and England (Park et al., 2009).

U.S. Bureau of Land Management BLM (Duffy-Deno, 1997a, 1997b, 1998; Hailu and Rosenberger, 2004; Lewis et al., 2002, 2003), and (5) topography (McGranahan, 2008).

Table 3.1

Studies investigating the role of landscape features in regional development.

Article	Landscape features	Measures[a]
Boarnet et al. (2005)	Agricultural land	Total area (census tract)
Deller and Lledo (2007)	Land-based amenities[b]	Index (PC analysis[c])
Deller et al. (2001)	Land-based amenities	Index (PC analysis)
Duffy-Deno (1997a, 1998)	Forest land	
	Public wilderness/preserved land	
	Other public lands	
Duffy-Deno (1997b)	Forest land	
	State parks	Number per acre county area
	Public wilderness/preserved land	
	Other public lands	
Hailu and Rosenberger (2004)	Forest land	
	Other public lands	
Kim et al. (2005)	Land-based amenities	Index (PC analysis)
Lewis et al. (2002, 2003)	Public wilderness/preserved land	
	Other public land	
	Forest land	
Lundgren (2009)	Preserved land	% Municipality area
McGranahan (2008)	Agricultural land[d]	
	Forest land	
	Topography	Map-based index (20 categories)
Nzaku and Bukenya (2005)	Forest land	
	Agricultural land[e]	% Agricultural land in county
Park et al. (2009)	Land-based amenities	Index (PC analysis)

[a] Empty cells: percentage of county area in the respective land use
[b] Contains measures for landscape amenities (e.g. cropland, pasture, national and state parks and forests, preservation and wilderness land) and measures for developed amenities and infrastructure (e.g. campground sites, trails, guide services).
[c] Principal component analysis
[d] Cropland
[e] Includes three categories of agricultural land: cropland, pasture and preserved agricultural land.

Most studies define the landscape variables as shares of land use types among the total land surface or – where alternative agricultural land use types are examined – among the total land in agriculture (Nzaku and Bukenya, 2005). Duffy-Deno (1997b) includes the number of state parks per acre in his model. A different approach for measuring landscape amenity endowment is the construction of indices using principal component analysis (Deller et al., 2001; Deller and Lledo, 2007; Kim et al., 2005; Park et al., 2009). This method allows to break down a variety of land cover and land-use related elements into one scalar measure. This approach tends to reduce multicollinearity and omitted variables bias. However, this advantage comes at the cost of a limited interpretability of the estimated parameters for this variable.

The empirical results of these studies can be summarized as follows. While Carlino-Mills studies tend to support the hypothesis that people are attracted by landscape amenities (e.g. Deller et al., 2001; Lewis et al., 2002; McGranahan, 2008; Park et al., 2009) the impacts on employment and income are ambiguous (Waltert and Schläpfer, 2010). However, some studies display separate estimates for direct and indirect or total effects and provide a more distinct insight into the complex relationships between amenities and the interplay of endogenous variables (e.g. Lewis et al., 2002, 2003; Lundgren, 2009; McGranahan, 2008). Moreover, several studies find that land conservation does not crowd out resource sector employment (Duffy-Deno, 1997a; Lewis et al., 2002) or at least not foster the replacement of resource sector jobs by low-wage jobs in the service sector (Lewis et al., 2003; Lundgren, 2009).

While the regional adjustment studies reviewed above shed light on the impact of landscape and other amenities on aggregate measures of economic development (population, employment, income) the economic processes underlying the spatial allocation of households and firms remain largely unclear. Roback (1982, 1988) provides a more rigorous microeconomic foundation to the Carlino-Mills framework and contributes to a deeper understanding of how amenities might play out in regional economic growth and development. In her equilibrium model of firm and household location she examines how spatial differences in wages and rents may be driven by levels of amenities. Recently this theoretical framework has been refined and applied to datasets containing natural and landscape amenity variables (e.g. Deller, 2009; Wu and Gopinath, 2008). The basic hypothesis is that people are willing to accept lower wages, pay higher rents, and risk higher levels of unemployment to live in high amenity areas.

3.2.2 Effects of policies related to land use

Except from a few studies considering inventories of preserved land and other public lands (e.g. Duffy Deno, 1997, 1997b, 1998; Lewis et al., 2002, 2003) the studies reviewed above focus on the effects of existing landscape amenities, while evidence on the role of amenity-regulated policies is scarce. However, landscapes are subject to a variety of policies targeting directly at preservation of landscapes but also at other goals such as securing agricultural production or preventing depopulation in remote regions. Land use regulation (e.g. landscape inventories and preservation regulations) and other amenity-related policies (e.g. agricultural subsidies) may affect regional development by influencing landscape quality as well as through direct impacts on production conditions, locational factors for firms and households and on land and other factor markets (e.g. Hardie et al., 2007; Quigley and Swoboda, 2007). Regional adjustment models offer an interesting opportunity for testing hypotheses about the effects and effectiveness of policies related to land use.

In the present study, we therefore also consider variables related to policy outputs. Following Gerber and Knoepfel (2008), it is useful to distinguish direct and indirect means of landscape regulation. Policy outputs that aim to directly regulate the landscape include the legislation related to the Federal Inventory of Landscapes and Natural Monuments of National Significance (Federal Council, 1998) and the Federal Inventory of Heritage Townscapes (Federal Council, 2000) under the Nature and Cultural Heritage Act. Inclusion in each of these inventories is used as explanatory variables in the present study.

Of major importance among policies that indirectly regulate the landscape are agricultural policies to which European countries and the European Union devote large shares of their budgets. A rising portion of those expenses is understood as a compensation for land use related “multifunctional services” including regional development. In Switzerland, agricultural policy is particularly active spending about 4 billion Swiss francs (about 3 billion Euro) annually which includes about 2 billion in income subsidies and targeted subsidies for ecological services (Bosshard et al. 2010). The amount of these subsidies at the community level (per capita) is used as an explanatory variable in this study.

Further policies that could influence the landscape indirectly include land use planning, tourism policy, infrastructure policies, and defense policy. Regarding land use planning there are indications that its effects on development remain relatively weak. Land use planning in Switzerland is characterized by a federalistic implementation. The federal law only lays down basic principles, and practical planning implementation is a matter of the cantons which in turn delegate tasks to the municipalities. It is widely acknowledged that restrictions on development through the cantonal "structure plans" and the municipal "land use plans" have been limited due to local interests in development and a high degree of local autonomy. Unlike the national inventories, land-use plans over the study period may be more usefully understood as a consequence of economic development than as an independent driving factor. The present study can only very indirectly shed light on effects of these further policies, through variables like the percentage of open space (as influenced by land use planning), hiking trail density (as influenced by tourism policy) or road distance to nearest urban centers (as influenced by infrastructure policies).

3.3 Conceptual framework

The underlying assumptions of the Carlino-Mills (1987) model are (1) spatially mobile, utility-maximizing households deriving utility from private goods and services and location-specific amenities, (2) spatially mobile profit-maximizing firms whose costs and revenues depend on local markets and business conditions. Hence, as migration of firms and households occurs, population and employment simultaneously adjust towards an unknown spatial equilibrium.[2] A basic version of a two-equation regional adjustment model in the spirit of Carlino and Mills is given by

(1) $$\widetilde{P}_t = f_P(P_{t-1}, \widetilde{E}_t, \Omega^P, u_P)$$

(2) $$\widetilde{E}_t = f_E(E_{t-1}, \widetilde{P}_t, \Omega^E, u_E)$$

(3) $$\widetilde{P}_t = P_t - aP_{t-1}$$

(4) $$\widetilde{E}_t = E_t - aE_{t-1}$$

where P_t and E_t and P_{t-1} and E_{t-1} represent end and start-of-period values for population and employment, Ω represents a vector of exogenous variables explaining differences in population and employment levels or changes, u contains unobserved effects of each equation and a is a scalar that is 1 if the endogenous variables are measured as changes or 0 if they are measured as levels. Hence, population and employment depend on each other as well as on initial conditions and exogenous factors. Depending on the value of

[2] For a detailed microeconomic derivation of the model see Steinnes and Fisher (1974) and Carlino and Mills (1987).

a the research focus is on explaining the adjustment process ($a = 1$) or the spatial structure of population and employment ($a = 0$).

Conceptually, the applications reviewed in the previous section vary in two important ways. The first concerns the choice of endogenous variables, their definition as changes (e.g. Deller et al., 2001; Kim et al., 2005) *vs.* levels (e.g. Duffy-Deno, 1997b, 1998), their measurement as densities (e.g. Hailu and Rosenberger, 2004; Lewis et al., 2003) *vs.* absolute values (e.g. Lundgren, 2009; Park et al., 2009) and the resulting number of equations. Some studies depart from the classical population-employment two-equation model by replacing endogenous variables[3] or adding additional equations for income[4] or land-use related variables.[5]

Second, the applications differ in terms of econometric specification and estimation of the system of equations. While not explicitly considered in older and some of the recent papers (e.g. Deller et al., 2001; Duffy-Deno, 1997a, 1997b, 1998; Park et al., 2009), the issue of spatial dependence and autocorrelation (see e.g. Anselin, 1988; Anselin and Bera, 1998) is increasingly addressed in studies on landscape impacts on regional development. Some researchers (Lewis et al., 2002, 2003; McGranahan, 2008) rely on "traditional" econometric models yet they examine spatial autocorrelation in the process of model selection by inspecting residual maps or by constructing a spatial weight matrix and testing the model residuals against the null hypothesis of spatial independence using the spatial autocorrelation statistic Moran's I (e.g. Anselin, 1988; Anselin and Bera, 1998). Depending on the outcomes, models are modified by including spill-over effects from adjacent locations (e.g. McGranahan, 2008). Other researchers follow Boarnet (1994) and choose spatially explicit approaches such as spatial error and spatial lag models (Boarnet et al., 2005; Kim et al., 2005; Nzaku and Bukenya, 2005).

[3] Lewis et al. (2002, 2003) and McGranahan (2008) use net migration instead of population change. Duffy-Deno (1997a, 1997b, 1998) replaces the employment equation by two separate equations for resource and nonresource employment. Lundgren (2009) estimates separate equations for forest and tourism sector employment.

[4] Deller et al. (2001), Deller and Lledo (2007), Kim et al. (2005), Lewis et al. (2003), Lundgren (2009), Nzaku and Bukenya (2005) and Park et al. (2009) introduce separate equations for per capita income, average wage income or income distribution.

[5] The endogenous land-use related variables used in the Carlino-Mills studies are the number of threatened and endangered species (Duffy-Deno, 1997a), state park density (Duffy-Deno, 1997b) and agricultural land density and value (Hailu and Rosenberger, 2004).

In the present chapter we use a two-equation regional adjustment model in order to study the role of amenities and amenity-related policies in explaining regional differences in population and employment growth. Applying the 3SLS estimator and testing for spatial autocorrelation using the Moran's *I* statistic, our approach is most closely related to Lewis et al. (2002) and McGranahan (2008).

3.4 Empirical estimation

3.4.1 Empirical model

Following e.g. Carlino and Mills (1987) and Lewis et al. (2002), and using Swiss municipalities as our units of observation, we estimate a structural model where population and employment changes are simultaneously determined. The empirical model is described by equations (5) and (6)

(5) $$\Delta POP = \eta_{0P} + \gamma_P \Delta EMPL + \lambda_P POP_0 + \omega_P \Omega_P + \varepsilon_P$$

(6) $$\Delta EMPL = \eta_{0E} + \gamma_E \Delta POP + \lambda_E EMPL_0 + \omega_E \Omega_E + \varepsilon_E$$

where η_0 are the intercepts, γ are the coefficients of the right-hand side endogenous variables, λ are the coefficients of the begin-of-period values, ω are the coefficients of the remaining independent variables Ω including amenities, and ε represents the error term of the respective equation. Hence, the following hypothesis is underlying this model: Population and employment change are determined by (1) historical growth patterns, (2) initial conditions and (3) amenities and other exogenous factors (demographic, economic and policy variables).

Two model specifications using the three stage least squares (3SLS) estimation procedure are estimated (see Table 3.3). Model 1 includes all amenity measures as independent variables in the population and the employment equation. In a second specification (Model 2) – where justifiable by theory – nonsignificant variables were removed and interaction variables introduced in order to test additional hypotheses (see 4.3).

The rank condition is sufficient for econometric identification of a simultaneous equations model. Hence, a rank condition test (Wooldridge, 2003, pp. 534–535) was conducted and its results suggest that both equations in both models are identified (see Table 3.3). The model specification was also based on tests for multicollinearity and spatial autocorrelation (see section 3.5.3).

3.4.2 Data

The sample includes 2467 out of 2740 Swiss municipalities, covering 92% of the Swiss population. The remaining 273 municipalities were omitted because of missing data or because of structural breaks caused by territorial changes (e.g. merged municipalities).[6] The time period considered in the analysis is from 1995 to 2005. Where data from these start-of-period and end-of-period years were not available, data from the years closest to these years were used. The choice of variables is comparable to related studies such as Deller et al. (2001), Duffy-Deno (1998), Hailu and Rosenberger (2004), Kim et al. (2005) and Lewis et al. (2002, 2003). The factors hypothesized to influence local development can be summarized in three groups: (1) initial conditions and "traditional" variables including demographic factors, fiscal factors, local and business factors, (2) location-specific amenities, and (3) amenity-related policy variables. Descriptions and descriptive statistics of all variables used in the regression analysis as well as data sources are provided in Table 3.2.

Dependent variables

The dependent variables of our two-equation system are percentage change of population (ΔPOP) and full time equivalent employment ($\Delta EMPL$) between 1995 and 2005. Fig. 3.1 provides a map for each dependent variable in order to give an overview of the spatial distribution of development. Population growth was above average in the periurban areas around the major cities of Zurich and Basel, as well as in suburban and certain rural parts of western Switzerland. On the other hand, widespread parts of the mountainous regions in southern and western Switzerland (Alps and Jura Mountains) experienced a decline in population. Employment concentrated around the metropolitan centers and in the periurban area between Zurich and Basel, while development in western Switzerland and in the mountainous regions was below average.

[6] The missing municipalities are marked in Fig. 3.1 („no data"). They are distributed all over the country and over the rural-urban continuum. Approximately half of them are classified as rural.

Table 3.2

Descriptive statistics of the variables used in regression analysis.

Variable name	Description	Source[a]	Mean	St. Dev.
ΔPOP	Change in permanent resident population, 1995-2005, in percent	A	6.87	12.87
ΔEMPL	Change in full time equivalent employment, 1995-2005, in percent	C	-5.79	26.29
POP1995	Permanent resident population, 1995 (in thousands)	A	2.60	10.15
EMPL1995	Full time equivalent employment, 1995 (in thousands)	C	1.21	7.53
INCOME	Per capita net income, 1995, in CHF 1000	E, A	26.89	7.33
FOREIGN	Foreigners, 1995, in percent of total resident population	A	10.49	8.32
NONACTIVE	Population that is younger than 20 years or older than 64 years, 1990, in percent	B	40.25	4.61
INCTAX	Tax burden for a married taxpayer with a gross income of CHF 70,000, 1995, in percent[c]	F	10.18	1.71
UNEMPL	Unemployment rate, 1990, in percent of total work force	B	1.61	1.32
UNIVERSITY	Persons with a university diploma, 1990, in percent of residents between the age of 25 and 64	B	4.11	3.81
EMPLS1	Employment in the primary sector, 1995, in percent	C	26.46	23.16
EMPLS3	Employment in the tertiary sector, 1995, in percent	C	42.48	19.43
LATIN	Dummy for municipalities with majority of people with French, Italian or Rhaeto-Romanic first language (1 = yes, 0 = no), 1990	B	0.39	0.49
METRODIST	Road distance to the nearest major city[b], in kilometers	H	58.18	51.18
REGDIST	Road distance to the nearest regional centre, in kilometers	H	15.52	10.49
TOTAL_AGRISUB	Federal subsidies to farmers (general payments and payments for ecological production), 1999, in 1000 CHF per capita	G, A	1.02	1.27
ECO_AGRISUB	Federal subsidies to farmers (payments for ecological production), 1999, in percent of *TOTAL_AGRISUB*	G, A	14.28	6.83
LAND_INV	Percent of municipality area listed in the Federal Inventory for Landscapes and Natural Monuments of National Significance (BLN), 2004	K, I	12.24	24.84
HERITAGE_INV	Dummy for national inventory of heritage townscapes (1=municipality listed in inventory, 0 otherwise)	J	0.32	0.47

(continued on next page)

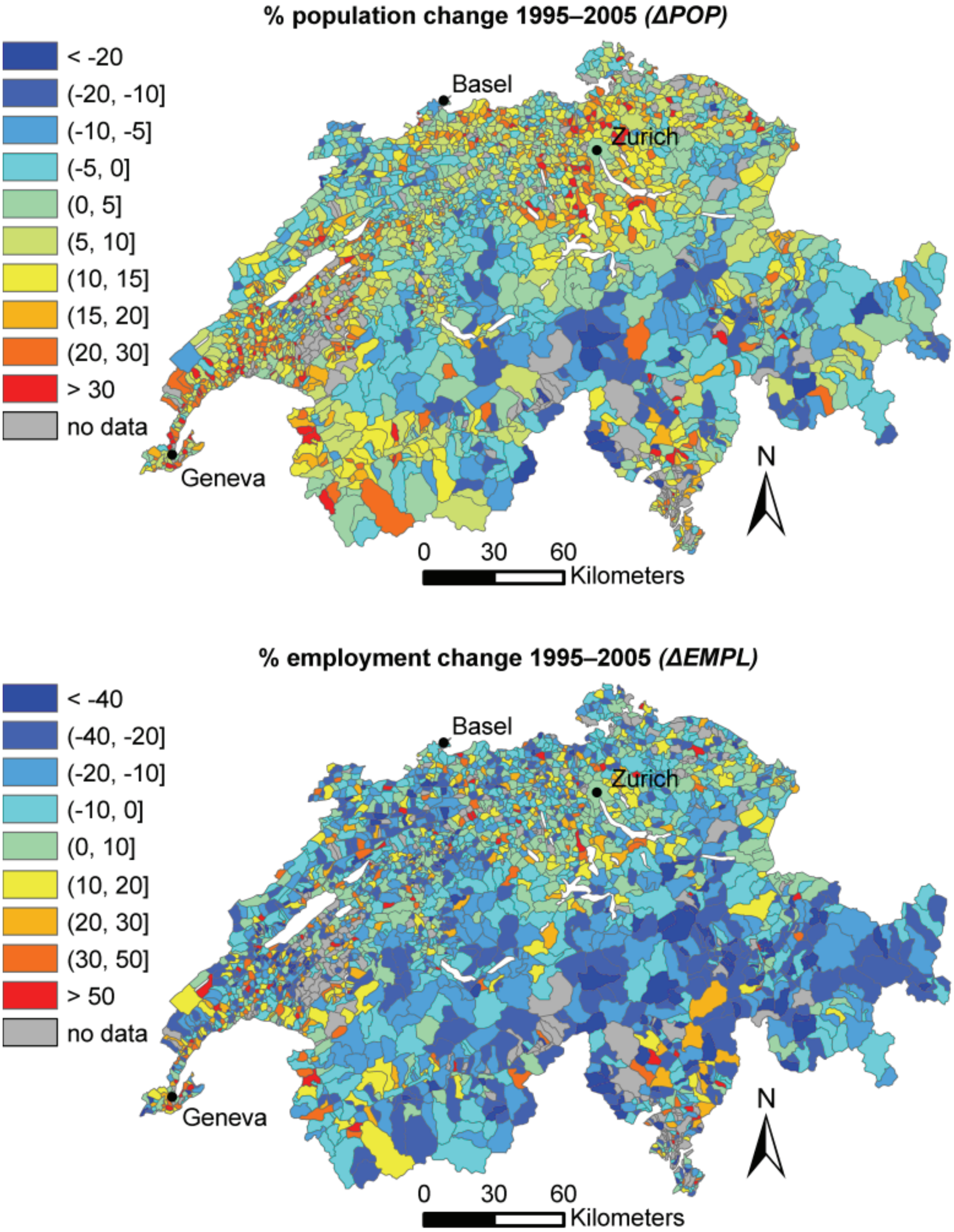
(Table 3.2, continued)

Variable name	Description	Source[a]	Mean	St. Dev.
OPENSPACE	Open space[d], in percent of non-forested municipality area	D	84.58	13.39
LAND_AMENITY	Percent of municipality area in near-natural landscape elements[e]	D	15.34	8.88
LAKEDIST	Distance to nearest major (>1 km^2) lake, in kilometers	I	13.49	10.92
HIKING	Hiking trail density, in kilometers per square kilometer	I	2.27	1.03
MOUNTAIN	Dummy for municipalities with altitude[f] greater than 900 meter, (1 = yes, 0 = no)	I	0.10	0.31
INC_HIGH	Dummy for municipalities belonging to the 25 percent with highest per capita income (1 = yes, 0 = no)	E	0.25	0.43

[a] Data sources: A: Federal Statistical Office, 1996, 2006; B: Federal Statistical Office, 1990; C: Federal Statistical Office, 1995, 2005; D: Federal Statistical Office, 1997; E: Federal Tax Administration, 2002; F: Federal Tax Administration, 1996; G: Federal Office for Agriculture, 2005; H: Institute for Transport Planning and Systems IVT, 2006; I: Federal Office of Topography swisstopo, 2004; J: Federal Council, 2000; K: Federal Council, 1998.
[b] Major cities: Zurich, Geneva, Basel, Bern and Lausanne.
[c] Since the tax burden data is only available for municipalities with more than 2000 inhabitants the tax burden of smaller communities was estimated using data on tax rates from the tax administration offices of the Swiss cantons.
[d] Contains the categories 3, 4, 5, 6, 7, 8, 9, 10, 14 of the Swiss land use statistics 1992/1997 (aggregation NOAS92_15).
[e] Contains the categories 13, 14, 17, 18, 73, 76, 77, 82, 87, 95, 96 of the Swiss land use statistics 1992/1997
[f] Altitude at the lowest point of the municipality area.

Fig. 3.1

Maps of the dependent variables.



Initial conditions and traditional exogenous variables

The independent variables were chosen as begin-of-period values in order to reduce direction-of-causation identification problems (see Carlino and Mills, 1987). A first set of independent variables are the initial conditions on population *(POP1995)* and employment *(EMPL1995)*. Demographic variables used in the model are the share of foreigners (*FOREIGN*) and the percentage of the population that is below 20 or above 64 years (*NONACTIVE*). The latter partly determines a region's market size and consumption ability (Deller et al., 2001). *FOREIGN* is included as a measure of the role of (foreign) immigration in years preceding the study period.

Two labor-market related factors are the unemployment rate *(UNEMPL)* and the percentage of university degree holders *(UNIVERSITY)*. *EMPLS1* and *EMPLS3* represent the relative sizes of the primary and tertiary business sectors of the local economy, respectively. *INCTAX* is the income tax burden (federal, cantonal and communal taxes). In general, a high tax burden is considered to hinder economic as well as population growth.

Further local features are captured by the four variables *INCOME*, *LATIN*, *METRODIST* and *REGDIST*. *INCOME* is the per capita income at the start of the reference period. *LATIN* is a dummy for the Latin (vs. Germanic) language regions. The variable was included in the model in order to capture some particularities of those regions such as relatively low levels of employment. Finally, the two GIS-constructed variables *METRODIST* and *REGDIST* measure the accessibility. While *REGDIST* – the road distance to the nearest regional centre – measures local accessibility, *METRODIST* is the road distance to the next major city which determines whether a municipality profits from agglomeration economies or is at least within commuting distance.

Amenity variables

Using GIS software on geo-referenced datasets, two landscape amenity measures and one amenity-related infrastructural measure were constructed. *OPENSPACE* measures the percentage of non-forested area that remains undeveloped. This comprises agricultural areas, woods, unproductive areas, and recreational open space (e.g. municipal parks, golf courses and cemeteries). *LAND_AMENITY* represents the share of municipality land in high-quality open space. The land uses included in this variable include water shore vegetation, fens, hedgerows, forest stripes, and extensively farmed agricultural land.[7] These landscape elements are particularly appreciated by locals and visitors for their aesthetic and recreational value. Only 13.2% of the country's total land surface belongs to this category (*OPENSPACE*: 64.7%) and the correlation of the two variables is relatively low (r = 0.10).

LAKEDIST is the distance from the municipality centre to the nearest major lake. *HIKING* is the density of hiking trails which serves as an indicator of the accessibility of the landscape for recreational uses.

Amenity-related policy variables

A variable *TOTAL_AGRISUB* measures total direct payments (subsidies) to farmers per capita of the local population. These payments contribute about 75% to the sector's income (Federal Office for Agriculture, 2008, p. A15). The payments are officially motivated by the intention to compensate farmers for the positive externalities of managing landscapes and preventing depopulation in rural and especially mountainous regions of the country (Federal Parliament, 1998). However, it is now widely accepted that most of these payments (an annual CHF 2 billion of so called *general direct payments* which depend on acreage and stocking rates) are not usefully targeted and may even adversely affect the environment and landscape quality (Federal Council, 2009; Bosshard et al., 2010). In addition to the general direct payments, a relatively small amount (1999: CHF 400 million, 2005: CHF 500 million) of so-called *ecological direct payments* (variable *ECO_AGRISUB*) are targeted payments for specific ecological and animal-friendly production standards and outcomes (Federal Office for Agriculture, 2003, 2007).

LAND_INV reflects the percentage of municipality area listed in the Swiss Federal Inventory for Landscapes and Natural Monuments of National Significance. This inventory is relevant to decisions about national infrastructure but does not imply any binding restriction on regional (cantonal) or local land use planning.[8] Finally, our model contains a dummy variable indicating whether a municipality is listed in the National Inventory of Heritage Townscapes *(HERITAGE_INV)*. Those townscapes are

[7] See Table 3.2.
[8] Administrative Review Commission of the National Council (2003).

legally protected (often including surrounding open space), and it is well known, and also intended by the legislator, that the protection status sometimes restricts land development. However, to our best knowledge, the effects of these policy variables on regional development have not been statistically examined so far.

3.4.3 Hypotheses

Each variable in the empirical model implies a specific hypothesis about the (direct) effect of that variable on local development. Regarding the role of amenities, we generally test the null hypothesis (of no effects) against the alternative that the amenities positively affect local population and employment change. In the case of amenity-related policies our expectations are less straightforward as protection of amenities (unlike targeted financial support) may also hinder growth (see section 3.5 for more detail). In addition to the direct effects we examine selected hypotheses about interaction effects. Specifically, we are interested in how the effects of high-quality open space (*LAND_AMENITY*) differ between higher-income and lower-income regions and whether the effects of the agricultural subsidies (*TOTAL_AGRISUB*) differ between lowland and mountain regions.

Furthermore, we use the model residuals to examine selected hypothesis about spatial autocorrelation in the data. Specifically, we use Moran's *I* and the local indicator of spatial autocorrelation LISA to examine if there are clusters of municipalities where population or employment change deviate from the predictions of the model (see section 3.5.3). Substantial spatial autocorrelation would violate the model's assumption of independent observations and suggest a cautious interpretation of the t-values (significance levels) in the regression model.

3.5 Results

The descriptive statistics indicate wide variation across communities in both the dependent and the independent variables (see Table 3.2). A correlation matrix of the explanatory variables is provided in the Appendix (Table 3.A.1). Regarding the variables for amenities and amenity-related policies we naturally observe that the variables for total agricultural subsidies (*TOTAL_AGRISUB*) and for the open space (*OPENSPACE*) are highly correlated (with a correlation coefficient > 0.4) with each other and with other variables that follow an urban-rural pattern, including employment in the first and third sector, percentage of foreigners, and distance to regional centers. The remaining amenity variables, however, are only very weakly correlated with each other or with other variables. Hence, multicollinearity is not a major issue in the interpretation of those effects.

Table 3.3 presents the model estimates. Model 1 includes the full set of amenity variables as independent variables in both equations. Since most amenity and amenity-related policy variables *(OPENSPACE, LAND_AMENITY, LAKEDIST, HERITAGE_INV, HIKING)* turn out to be nonsignificant in the employment equation, we provide a second specification (Model 2) which omits the nonsignificant variables and introduces two interaction terms to examine how amenity effects differ between regions and income levels (see section 3.4.3). For most variables the signs and significance levels did not change between the models. We therefore focus on the estimates in Model 1 and mention those in Model 2 only where the specification or estimated effects change.

An analysis of spatial patterns in the regression residuals of the presented models is presented in section 3.5.3.

3.5.1 Population equation

Initial conditions and traditional exogenous variables

The coefficient on the right-hand side endogenous variable *ΔEMPL* indicates that municipalities with higher employment growth during the 1995 to 2005 reference period also tended to grow faster in population (see Table 3.3). Start-of-period population levels played a significant role in determining subsequent population growth. The negative coefficient for *POP1995* indicates convergence patterns. Smaller municipalities grew faster than larger ones and rich locations attracted more in-migrants than poorer ones *(INCOME)*. The coefficient for the share of foreigners *(FOREIGN)* is negative and highly significant. Since foreigners tend to concentrate in urban areas, this variable may partly reflect the low dwelling vacancy rates as well as several disamenities associated with metropolitan centers such as pollution, traffic, noise exposure and crime.

As predicted by theory, a high tax burden dampens in-migration; the coefficient on *INCTAX* is highly significant and negative. The coefficients on *LATIN* indicate that population growth was significantly higher in the French and Italian than in the German language regions. *REGDIST* had the expected negative effect on population growth, reflecting the limited attractiveness of remote regions as place of residence. Furthermore, population growth was declining with increasing distance to the nearest major metropolitan centre (*METRODIST*).

Table 3.3

3SLS estimation results for change in population and employment (t-values in parentheses)[a].

Variable name	Model 1		Model 2	
	ΔPOP	ΔEMPL	ΔPOP	ΔEMPL
Intercept	2.817 (0.671)	25.204** (2.521)	5.387 (1.341)	8.491 (1.111)
ΔPOP (instrument)		0.299 (1.608)		0.457*** (3.045)
ΔEMPL (instrument)	0.221* (1.934)		0.111 (0.963)	
POP1995	-0.061** (-2.287)		-0.071*** (-2.816)	
EMPL1995		-0.057 (-0.782)		-0.024 (-0.343)
INCOME	0.341*** (8.095)		0.245*** (5.454)	
FOREIGN	-0.227*** (-4.956)	0.192** (2.023)	-0.200*** (-4.542)	0.271*** (3.149)
NONACTIVE		-0.544*** (-3.211)		-0.364** (-2.306)
INCTAX	-0.531*** (-2.939)		-0.369** (-2.032)	
UNEMPL		-0.045 (-0.125)		-0.181 (-0.463)
UNIVERSITY		0.030 (0.177)		-0.035 (-0.204)
EMPLS1		-0.049 (-1.610)		-0.065** (-2.053)
EMPLS3		0.042 (1.362)		0.056* (1.701)
LATIN	5.392*** (8.352)	0.006 (0.004)	5.431*** (8.934)	-0.481 (-0.360)
METRODIST	-0.027*** (-2.984)	-0.044*** (-3.241)	-0.031*** (-3.507)	-0.045*** (-3.447)
REGDIST	-0.101*** (-2.747)	-0.159** (-2.423)	-0.130*** (-3.642)	-0.154** (-2.575)

(continued on next page)

(Table 3.3, continued)

Variable name	Model 1		Model 2	
	ΔPOP	ΔEMPL	ΔPOP	ΔEMPL
TOTAL_AGRISUB	-0.896***		-1.214***	
	(-2.622)		(-3.153)	
*TOTAL_AGRISUB*MOUNTAIN*			0.378	
			(1.210)	
ECO_AGRISUB	0.179***		0.177***	
	(4.291)		(4.341)	
LAND_INV	0.010	-0.040*	0.006	-0.046**
	(0.966)	(-1.907)	(0.619)	(-2.256)
HERITAGE_INV	-1.474***	-0.279	-1.674***	
	(-2.672)	(-0.244)	(-3.396)	
OPENSPACE	0.062**	-0.075	0.048*	
	(2.057)	(-1.328)	(1.791)	
LAND_AMENITY	0.038	0.035	0.005	
	(1.275)	(0.556)	(0.195)	
*LAND_AMENITY*INC_HIGH*			0.217***	
			(4.668)	
LAKEDIST	-0.088***	-0.022	-0.092***	
	(-3.612)	(-0.407)	(-4.224)	
HIKING	-0.362	-0.875	-0.583**	
	(-1.270)	(-1.585)	(-2.233)	
Number of Observations	2467	2467	2467	2467
Adj. R-Squared OLS	0.256	0.109	0.264	0.109
McElroy R-Squared (System)	0.397		0.327	
Rank condition test Pr (>F)	0.0087***	0.0000***	0.0233**	0.0000***
Moran's *I*	< 0.09***	< 0.04	< 0.11***	< 0.04

[a] Significance levels: *** 1%, ** 5%, * 10%

Amenity variables

The results for the amenity and amenity-related policy variables are mixed. The abundance of undeveloped land *(OPENSPACE)* has a positive effect on population growth. However this result may not be entirely driven by the role of open space as an amenity. The estimated coefficient may also reflect other positive effects of a low population density such as an abundance of land for development resulting in relatively low land prices, but also high levels of environmental quality with respect to pollution and noise.

The amount of land in high-amenity landscape features, *LAND_AMENITY*, is positive but not significant. Hence, we find no evidence for an overall effect of these attractive landscape features on population.[9] To examine this in more detail, we also applied the model to subsamples of municipalities that are particularly rich/poor in amenities. The coefficient on *LAND_AMENITY* is positive and significant among the 25% of municipalities with the lowest *LAND_AMENITY* values. Furthermore, since the attractiveness of landscape amenities may vary for different segments of the population, we also tested the hypothesis that amenity effects depend on income in the communities. We included the interaction of *LAND_AMENITY* with a dummy variable for high income communities (highest 25%; variable *LAND_AMENITY*INC_HIGH* in Model 2). The interaction term is highly significant (and positive) suggesting that the effect of attractive landscape features on population growth indeed depends on income.

The scenic and recreational value of lakes is clearly confirmed by the highly significant negative coefficient on *LAKEDIST* in the population equation. In contrast, we did not find a consistent effect of the accessibility of the landscape as measured by hiking trail density (*HIKING*) in the two model specifications. Our expectation concerning this variable was less clear since, in some regions at least, hiking trails may be beneficial mainly to visitors rather than to local residents.

Amenity related policy variables

Apart from potential effects of the existing pattern of landscape amenities we were also interested in examining whether specific public policies designed to maintain or promote amenities are reflected in population change.

Our first hypothesis concerns the effects of direct payments to farmers through agricultural policy (see 4.2). Due to negative externalities associated with intensive agricultural production we hypothesized that the level of total agricultural subsidies per capita would not positively affect population change. On the other hand, we expected that the amount of targeted ecological direct payments would have a positive impact. The estimates support these hypotheses. The effect of total direct payments (*TOTAL_AGRISUB*) is negative and highly significant, while the share of targeted payments for environmental services (*ECO_AGRISUB*) is positive and highly significant

[9] Model estimations with alternative *LAND_AMENITY* definitions support this finding. Significantly positive effects on population growth were only found when the variable is defined less strictly (e.g. agricultural open space) and hence larger areas are included.

in both models.[10] In order to test whether there is a positive effect of the general payment level at least in the mountainous regions – where these payments may prevent land abandonment and population decline –, we also include an interaction variable containing a dummy for mountainous communities (*TOTAL_AGRISUB*MOUNTAIN*). Indeed there is a positive coefficient on this interaction variable although it is not significant. Hence, there is no evidence that the direct payments to farmers prevent depopulation in the mountainous regions of Switzerland.

The second policy related hypothesis we examine is whether regulations concerning federally protected landscapes and townscapes affected population change. The amount of land listed in the federal inventories for landscapes and natural monuments of national significance *(LAND_INV)* did not affect population change. This is not surprising since this inventory does not impose any binding restrictions for local authorities and landowner (see section 3.4.2). Municipalities with heritage townscapes *(HERITAGE_INV)* grew significantly less than municipalities not listed in the heritage inventory.

3.5.2 Employment equation

The coefficient on the right-hand side endogenous variable *ΔPOP* is positive but not significant in the employment equation. Start-of-period employment levels as well as the unemployment rate *(UNEMPL)* and the percentage of individuals with a university diploma *(UNIVERSITY)* had no significant effect on employment growth. However, municipalities with a high proportion of foreigners in 1995 *(FOREIGN)* had a significantly higher job growth in the subsequent period. As expected, municipalities with a high proportion of minors and senior citizens *(NONACTIVE)* experienced lower growth in the number of jobs. No significant effects were found for the employment shares of the economic sectors (*EMPLS1* and *EMPLS3*).

High accessibility and the proximity to major cities *(REGDIST* and *METRODIST)* foster employment growth. The coefficients are slightly higher than in the population equation, suggesting that accessibility is even more important as a locational factor to firms compared to households.

[10] The correlation coefficient between the two variables is –0.25.

While we found that abundance of open space *(OPENSPACE)* significantly promotes population growth, no such effect was found for growth in jobs. Furthermore we found no relation between valuable landscape features *(LAND_AMENITY)* and employment growth. However, the positive and significant (Model 2) coefficient on *ΔPOP* in the employment equation suggests that landscape amenities may promote employment growth indirectly by promoting population growth, which again is a significant determinant of employment growth. *LAKEDIST* and hiking trail density are not significant in the employment equation.

Somewhat unexpectedly, listing in the national landscape inventory (*LAND_INV*) has a negative effect on employment growth. In principle, landscape protection would be expected to hinder population and employment growth through land-use restrictions. However, as explained above, the federally mandated land use regulations in those federally listed landscapes only concern national infrastructure projects and resource-extracting industries are virtually inexistent in Switzerland. Therefore the significant negative effect may rather reflect the remoteness of many areas that are part of the landscape inventory. Unlike in the population equation, *HERITAGE_INV* is not significant in the employment equation.

3.5.3 Spatial pattern of regression residuals

Spatial correlation of regression residuals is a common issue in models based on spatial data and leads to inefficient estimates and biased standard errors (Leggett and Bockstael, 2000). In order to test for spatial autocorrelation we tested the residuals of all model equations using the spatial autocorrelation measure Moran's *I* (see Table 3.3). The tests were based on different spatial weights: 6 threshold distance weights (5 to 50 km) and 5 weights of the *k* nearest neighbors type ($3 \leq k \leq 50$). The test results suggest that global spatial autocorrelation is relatively weak in our two models and only statistically significant in the population equations (Moran's $I < 0.11$). No evidence was found for global spatial correlation of the employment change residuals and the same applies for cross-correlations between the residuals of the population and employment change equations. In order to identify local autocorrelation clusters in the population equation, we also calculated a local version of Moran's *I* by the local indicator of spatial association LISA (Anselin et al., 2006) (see Fig. 3.A.1). Between proximate municipalities (k=5) the spatial distribution of clusters is inconspicuous. When correlations within larger areas (k=25) are examined however, the following pattern emerges: Larger clusters of positively correlated positive regression residuals ("high-high") exist in mainly sub- and periurban regions around the major cities of Zurich and Basel and in the region of Lake Geneva. This type of positive autocorrelation most likely results from agglomeration effects which are not fully captured by the model. Clusters of municipalities for which the model overestimates population growth were found mainly in rural regions of the northwestern part of Switzerland.

3.6 Discussion

The results of this analysis using Swiss municipality data support earlier findings that landscape amenities are important determinants of local development – along with "classical" locational factors such as tax burden and accessibility. On average, Swiss regions with high abundance of open space and proximity to major lakes grew faster in population than other regions, while job growth may be only indirectly affected. These results are similar to those in the recent studies by Lewis et al. (2002, 2003) and Park et al. (2009).

Positive effects of managed landscape elements like hedgerows, vineyards and orchards (as measured in the variable *LAND_AMENITY*) are found among communities that are particularly poor in such amenities, and the effect was significantly larger in communities with high incomes. These results are consistent with the high income elasticity of demand and decreasing marginal utility of these amenities found in the analysis of voting patterns on amenity financing (Schläpfer and Hanley, 2003). On average, however, municipalities with major managed landscape amenities did not grow faster than those without these attributes. Likewise, municipalities with nationally significant landscapes and townscapes did not experience increased population or employment growth. Possible explanations are that a substantive portion of the mobile population is young individuals and immigrants in search of job opportunities.[11] Moreover, households in Europe are less geographically mobile than in the U.S. (Cheshire

[11] Clark and Hunter (1992) find that young professionals and graduates in the U.S. choose locations mainly based on labor market opportunities and that the importance of amenities rises with age.

and Magrini, 2009).[12] Finally, the negative effect on employment in municipalities that are included in the national landscape inventory may be a result of land-use planning decisions in line with the national objective of preserving those landscapes.

A caveat concerns our finding that employment was not positively affected by landscape amenities. Important built amenities related to the use of landscapes, such as mountain railways and other tourism-related infrastructure, were not considered in the present study. Deller et al. (2005) showed that areas tend to profit from their natural amenities in terms of employment growth when investing in amenity-related infrastructure. Richness in natural amenities is not a sufficient condition for local economic growth (Power, 2005). This might be particularly true for tourism-depending regions in the Swiss Alps. In urbanized regions, a further possible explanation for the differences in amenity impacts between the population and the employment equation is the "willingness-to-commute" which is generally high in Switzerland. People prefer to live in periurban areas where natural as well as urban amenities are accessible, while they are working in the agglomerations (see also section 3.4.2: dependent variables). A consequence of this growth pattern is (ex-)urban sprawl (Power, 2005, p. 76).
As a further caveat that applies to all our results the model does not control for rents, housing prices, and local wage levels. According to Roback (1982, 1988), richness in location-specific amenities may at least partly be compensated by lower wage levels and higher property prices (see section 3.2.1). This effect tends to decrease migration to amenity-rich regions.

The finding of limited positive effects of managed landscape amenities at the local level may have implications from a public finance perspective. If the municipalities do not have substantial economic benefits from their managed landscape amenities and amenity-related policies, local authorities will not have an incentive to implement these policies in the national interest. From a public finance perspective, this finding suggests that these policies should be financed by the national government.

Regarding the effects of the agricultural support payments, our results suggest that the major type direct payments (the *general direct payments*, which are partly related to stocking densities and conditional on only minimal cross-compliance re-

[12] Cheshire and Magrini (2009) who examined the drivers of population and per-capita GDP growth in Europe between 1978 and 2000 find that amenities mattered only within countries and suggest that internal migration is partly substituted by commuting as a reaction to spatial disequilibrium.

strictions) do not fulfill the political objective of preventing depopulation in rural areas. This finding may partly reflect negative externalities associated with intensive agricultural production, for example odor emission and reduction of biodiversity. While the result should be interpreted with caution, it parallels the conclusion from a recent Swiss modeling study (Buchli et al., 2005). Moreover, Goetz and Debertin (1996) found that U.S. farm programs – federal subsidies depending on cropland usage – foster out-migration from rural regions due to a slowdown of structural change and capital-labor substitution in agriculture. However, the negative association of the total agricultural support payments with population growth may also reflect an inherent statistical association of agricultural subsidies *per capita* and high population density in rapidly growing municipalities. In relatively large and rapidly growing peri-urban municipalities agricultural subsidies per capita are relatively low as a consequence of the high population density. Conversely, in many rural municipalities, the subsidies per capita are high as a consequence of the low population density. The finding that the negative association tends to be weaker for municipalities at high elevations where densely populated and rapidly growing municipalities rarely occur, is compatible with this explanation. The negative statistical association might then override any (potentially positive) effects of the subsidies on population.

The situation is completely different for the targeted *ecological direct payments*, which are conditional on ecological production standards. This result seems to support current political intentions to shift public funding from cross-compliance and production related income support to targeted payments for environmental services (Bosshard et al., 2010; Federal Council, 2009).

In principle, the instruments of land use planning could have important effects on the local development of population and employment. As mentioned (section 3.2.2) we were not able to examine those effects in the present study. We argued that land use planning in Switzerland may have been largely endogenous to date and that the effects of land use planning on economic development may have been modest so far. Nevertheless, it would be interesting to examine such effects in future studies. In the case of Switzerland, we would expect that any such effects would differ among the cantons since the cantonal authorities are known to implement the national planning principles with varying ambition.

3.7 Conclusion

This chapter provided structural-form estimates of a regional economic simultaneous equations model in the tradition of Carlino and Mills (1987) in order to shed light on the role of landscape amenities in local development. The results of this analysis using Swiss municipality data are consistent with earlier findings that amenities can be important determinants of local development – along with "classical" locational factors such as tax burden and accessibility. The findings concerning our research questions can be summarized as follows:

(1) "Traditional" locational factors show a pattern consistent with earlier research. Population growth is positively affected by income and accessibility and by employment growth (Model 1) while a high percentage of immigrants and a high tax burden hamper growth. We observe convergence in population size between smaller and larger municipalities. Employment growth is driven by population growth, immigration of foreigners and accessibility. Communities with a highly service-oriented sectoral structure and a small nonactive population (Model 2) tended to grow faster.

(2) Regarding landscape amenities, we find that people are attracted to communities near lakes and communities with abundant open space. Richness in traditional landscape elements such as hedgerows, orchards and fens is not generally significant, but the effect increases with income and scarcity of amenities. No effect was found for the accessibility of landscape as measured by density of hiking trails. Landscape amenities do not appear to directly drive employment change. However, Model 2 suggests that population growth – which is partly explained by amenity-induced immigration – tends to promote employment growth.

(3) Although the income support of Swiss agricultural policy is partly motivated by the intention to prevent depopulation in remote areas, we find a negative association with population growth. In contrast, we observe a positive association of targeted agri-environmental payments with population growth.

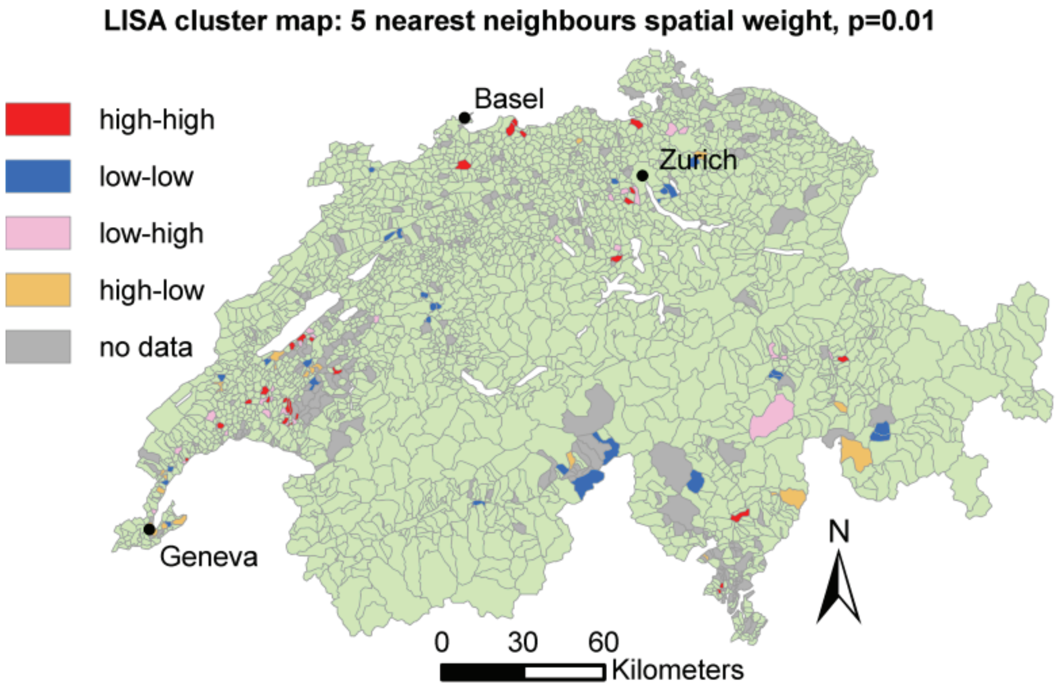
(4) Municipalities with nationally significant heritage townscapes had less population growth and municipalities that are part of an inventory of nationally significant landscapes experienced less employment growth than others. These findings suggest that the main responsibility for the financing of these amenities should remain with the federal government.

Regarding future research topics we suggest that increased attention to migrants' socioeconomic characteristics and particularly to life-cycle effects would be useful to further advance the understanding of amenity-induced migration. Which individuals are attracted by which amenities and what are the implications with regard to regional economic development? A further topic deserving more attention is interaction effects of natural and built amenities (e.g. tourism-relevant infrastructure) on regional growth. Which infrastructure is necessary for a successful and sustainable amenity-based development strategy? Finally, at larger time scales, amenity-induced migration is likely to feed back on landscapes amenities like open space. Future research should take these feedback effects into account in order to help mitigate potential conflicts between the interests of regional development and policies to maintain landscape amenities.

Appendix

Fig. 3.A.1

LISA cluster maps for the residuals of the population equation (Model 1)



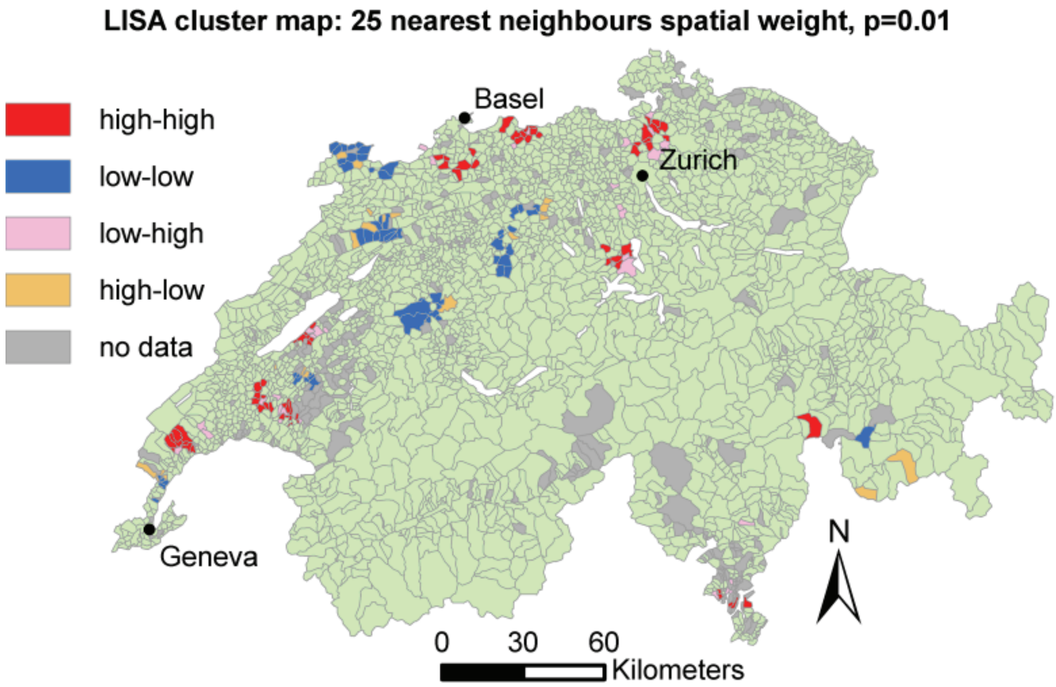


Table 3.A.1

Correlation matrix of the explanatory variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
ΔPOP (1)	1.00																							
ΔEMPL (2)	0.22	1.00																						
POP1995 (3)	-0.03	0.06	1.00																					
EMPL1995 (4)	-0.03	0.04	0.98	1.00																				
INCOME (5)	0.37	0.18	0.11	0.08	1.00																			
FOREIGN (6)	0.05	0.17	0.26	0.21	0.28	1.00																		
NONACTIVE (7)	-0.30	-0.20	-0.15	-0.12	-0.44	-0.39	1.00																	
INCTAX (8)	-0.02	-0.02	-0.07	-0.05	-0.37	-0.27	0.24	1.00																
UNEMPL (9)	0.07	0.04	0.08	0.07	0.13	0.28	-0.11	-0.04	1.00															
UNIVERSITY (10)	0.30	0.16	0.12	0.10	0.67	0.30	-0.29	-0.12	0.24	1.00														
EMPLS1 (11)	-0.06	-0.19	-0.20	-0.15	-0.32	-0.58	0.42	0.35	-0.18	-0.16	1.00													
EMPLS3 (12)	0.07	0.15	0.21	0.17	0.34	0.41	-0.29	-0.27	0.23	0.30	-0.60	1.00												
LATIN (13)	0.12	-0.01	-0.07	-0.05	0.00	0.14	0.03	0.23	0.28	0.22	0.13	0.00	1.00											
METRODIST (14)	-0.27	-0.18	-0.09	-0.06	-0.24	0.06	0.19	-0.37	0.08	-0.26	-0.07	0.07	0.20	1.00										
REGDIST (15)	-0.25	-0.21	-0.18	-0.13	-0.27	-0.17	0.35	-0.02	-0.02	-0.20	0.23	-0.14	0.16	0.35	1.00									
TOTAL_AGRISUB (16)	-0.22	-0.23	-0.15	-0.10	-0.40	-0.45	0.43	0.20	-0.12	-0.26	0.69	-0.43	0.15	0.15	0.42	1.00								
ECO_AGRISUB (17)	0.26	0.17	0.09	0.07	0.36	0.14	-0.25	0.01	-0.05	0.33	-0.10	0.04	-0.15	-0.46	-0.31	-0.25	1.00							
LAND_INV (18)	-0.03	-0.06	-0.03	-0.03	0.01	0.00	-0.01	-0.19	0.00	-0.03	-0.05	0.07	-0.08	0.12	0.06	-0.03	-0.09	1.00						
HERITAGE_INV (19)	-0.10	-0.04	0.08	0.07	0.00	0.10	0.05	-0.07	0.04	0.04	-0.10	0.11	0.04	0.13	0.09	-0.05	-0.04	0.14	1.00					
OPENSPACE (20)	-0.15	-0.21	-0.38	-0.32	-0.43	-0.58	0.46	0.24	-0.15	-0.35	0.54	-0.39	0.07	0.15	0.45	0.48	-0.34	0.08	-0.04	1.00				
LAND_AMENITY (21)	-0.04	-0.03	-0.06	-0.07	-0.11	-0.18	0.16	0.05	-0.12	-0.11	0.13	-0.14	-0.29	-0.13	-0.02	0.09	-0.05	0.09	-0.12	0.10	1.00			
LAKEDIST (22)	-0.18	-0.08	-0.03	-0.02	-0.15	-0.18	0.10	-0.08	-0.11	-0.19	0.05	-0.13	-0.22	0.06	0.18	0.16	0.02	-0.03	0.02	0.09	0.07	1.00		
HIKING (23)	0.06	-0.03	-0.06	-0.04	0.06	-0.05	-0.04	0.04	-0.02	0.05	0.08	-0.08	0.04	-0.02	-0.06	-0.01	0.15	-0.04	-0.06	-0.07	0.09	-0.02	1.00	
MOUNTAIN (24)	-0.24	-0.19	-0.06	-0.04	-0.16	-0.10	0.20	-0.22	0.06	-0.18	0.09	0.06	0.06	0.47	0.47	0.35	-0.36	0.05	0.07	0.30	-0.11	0.11	-0.05	1.00

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How Local Landscape Resources Affect Apartment Prices: Evidence from a Hedonic Pricing Model

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Chapter 4

How Local Landscape Resources Affect Apartment Prices: Evidence from a Hedonic Pricing Model

4.1 Introduction

Urbanization and loss of natural environment lead to a scarcity of landscape resources. As essential component of ecosystems, landscapes provide a variety of ecosystem goods and services and associated ecological, socio-cultural and economic values (de Groot et al., 2002). The quantification of these benefits can help to improve political decisions concerning provision, management and financing of landscape-related amenities at a municipal, regional and national level. A better knowledge of how landscape resources affect the local economy may contribute to a more sustainable use of publicly accessible environmental goods.

One approach that has been successfully used to measure the benefits of local environmental goods including landscape resources is the hedonic pricing method. The hedonic pricing (HP) approach is an indirect method to estimate economic values of environmental goods by revealing buyers' preferences over housing attributes including local public goods. After initial studies of the relationship between air pollution and property values (Freeman, 1974; Nelson, 1978; Palmquist, 1983) numerous studies on forestry and agricultural impacts on property prices followed (e.g. Anderson and Cordell, 1988; Garrod and Willis, 1992a, 1992b; Kim and Johnson, 2002; Le Goffe, 2000; Palmquist et al., 1997; Tyrväinen, 1997; Tyrväinen and Miettinen, 2000). These studies measured the amenity values of landscape features such as woodland, trees, forest, grassland, wetland and pastureland. Studies by Cho et al. (2008), Geoghegan (2002), Irwin (2002), Marshall (2004), Riddel (2001), Smith et al. (2002) and Walsh (2007) further integrated the amenity variable "open space" in their models to explain the scarcity of landscape resources caused by urbanization processes. In recent years, new geographic information system (GIS) technologies and a higher availability of high-resolution land-use and land cover data increasingly allowed extensive spatial analysis.

Due to a large variation in local landscape amenities and a multitude of landscape data, Switzerland is an excellent case for applying the HP approach to local landscape resources. We intend to expand the revealed preference literature on landscape valuation in four ways: Firstly, most prior studies focus on only one particular landscape resource to measure the willingness to pay. In contrast to these studies, we test the impact on property prices for a variety of different landscape and land-use related community features. Secondly, while earlier studies worked with spatially limited study regions (neighborhood/municipality/county) and smaller samples, we estimate HP functions using a cross section of data gathered from 80814 domiciles in 956 Swiss communities distributed throughout the country. Thirdly, rather than transaction prices of owner-occupied housing we observe rental prices in the large and highly liquid Swiss rental market. Fourthly, along with natural amenities and landscape management and in contrast to most earlier studies, we included a variable for historical heritage in our model. Combined with traditional European cultural landscapes, historical townscapes are of high importance for the identity of Swiss communities.

This chapter consists of seven sections. In the next section the literature on hedonic pricing and landscape values is introduced. The empirical model is described in section 4.3. Section 4.4 contains a detailed report on the study region and the dataset. The results of our analysis are presented in section 4.5 and discussed in section 4.6. The final section (section 4.7) concludes.

4.2 Local landscape benefits and hedonic models

4.2.1 Benefits of local landscape

The economic value of benefits provided by local landscape resources can be subclassified into three main value components: use values, option values, and nonuse values (Tietenberg, 2006). Use values reflect the direct use, option values implicate the possible future use and nonuse values reflect unused but existent environmental resources. Our approach focuses on use values, which imply the direct use of landscape resources.

Most publications focus on use values by measuring the benefits of few local landscape resources such as wetland, green space and woodland. For instance, Costanza et al. (1989) emphasize three categories of benefits of wetland: commercial fishing, recreation and storm protection. Burel and Baudry (1995) found that hedgerow network landscapes considered as greenways provide agronomic, ecological, aesthetic and cultural benefits. Similarly, the study by Ndubisi et al. (1995) analyzed the ecological and environmental benefits from greenway corridors. Additionally, Fabos (1995) found that greenway movement influences recreational benefits. Finally, Tyrväinen (1997) and Tyrväinen et al. (2007) pointed out that urban forest and green areas provide social, economic and environmental benefits, and Medley et al. (2003) analyzed the impact of the historical change in forest cover on the benefits for land owners.

4.2.2 Hedonic property value models

The theoretical and methodical basis of the hedonic pricing approach was established by Rosen (1974) and Freeman (1974, 1979) who also showed how this approach can be used for studies of the relationship between environmental amenities and property value. The HP technique consists of two steps: (1) The hedonic price equation can be used to estimate marginal implicit prices of amenities by regressing observed prices on a set of variables explaining the characteristics of the property and its vicinity and (2) the implicit prices allow to estimate inverse demand functions. The latter step is omitted in most papers using the HP method.

Brawn and Rosen (1982) enhanced Rosen's (1974) first approach. They developed a two step model with a demand and a supply function, paying particular attention to marginal price. They discovered that constructed marginal attribute prices do not play the same role as directly observed available prices. Epple (1987) used a similar approach for different products and showed that unmeasured characteristics cause biased estimates. Atkinson and Crocker (1987) tested the robustness of hedonic property value studies with a Bayesian approach. They pointed out that hedonic models with systematic use of prior information can break the collinearity deadlock in the data.

The functional form is an important issue in specifying hedonic models. Cropper et al. (1988) examined how errors in measuring marginal prices vary with the specification of the hedonic price function and showed that linear and quadratic Box-Cox forms perform best for completely observed attributes.

More recently, the issue of spatial autocorrelation and spatial dependence – occurring when omitted variables are spatially correlated or spatial externalities are at work – is addressed in HP studies. Can (1992) improved the HP model by considering spatial externalities such as adjacency effects in her model specifications and showed that the consideration of these effects leads to the inclusion of spatial dependence. Increasingly, spatial regression techniques which explicitly incorporate spatial effects (e.g. spatial error and spatial lag models, see Anselin, 1988, 2002) are employed (e.g. Acharya and Bennett, 2001; Leggett and Bockstael, 2000; Munroe, 2007). Based on Parsons' (1990) first weighted hedonic regression approach, Cho et al. (2006) compared spatially weighted hedonic models and pointed out that the use of locally weighted regression allows to test for spatial variation in the strength of amenity effects (*spatial nonstationarity*).

4.2.3 Hedonic models of landscape benefits

Numerous HP studies on the impact of natural amenities on property prices measured the values of landscape features such as woodland, trees, forest, grassland, wetland, agricultural land, pastureland, open space and watercourses. For example, Anderson and Cordell (1988) associated abundance of trees with price increase as well as increases in the tax base of a community. Garrod and Willis (1992a) emphasized the recreational benefits of woodland. Similarly, Tyrväinen (1997) analyzed non-wood benefits derived from aesthetic landscapes as well as recreational activities. Kim and

Johnson (2002) expanded the model to include aesthetic and ecological factors, and Le Goffe's study (2000) integrated the non-market environmental goods of agricultural and forestry produce benefits. Le Goffe (2000) provides evidence on agricultural and forestry externalities with negative impact on property prices. Later, Bastian et al. (2002) estimated values of environmental amenities and agricultural land. The study showed that diverse and remote agricultural lands command higher prices than landscapes which are dominated by agricultural production. Further studies by Cho et al. (2008), Geoghegan (2002), Irwin (2002), Marshall (2004), Riddel (2001), Smith et al. (2002) and Walsh (2007) focused on the role of open space. Furthermore, Barbier (1993), Boyd and Wainger (2002), Cho et al. (2006), Costanza et al. (1989), Leggett and Bockstael (2000), Mahan et al. (2000) and Smith et al. (1983) measured the value of water-related natural amenities using a HP approach. The results showed that the quality of water-related natural amenities has an impact on recreational activities and the tourism sector.

4.3 Empirical specification

We follow Freeman (1993) who defined the hedonic price function using three vectors for (1) structural characteristics of the dwelling, (2) the characteristics of the neighborhood, and (3) location-specific environmental amenities. Hedonic models are reduced form statistical models. They describe the transaction prices as a function of the characteristics of the heterogeneous real estate. Since real estate is a complex good with many dimensions, differences in rental prices will be explained by a number of factors. These include the quality of the property structure, neighborhood characteristics, the accessibility, and environmental and other amenities associated with the property (Geoghegan, 2002). In contrast to former studies, we use a particularly broad set of variables describing local environmental resources (see section 4.4.2). Our empirical model is described by the following equation:

$$(1) \qquad RENT = \alpha_0 + \beta_1 S + \beta_2 C_1 + \beta_3 C_2 + \beta_4 C_3 + \beta_5 C_4 + \beta_6 C_5 + \beta_7 R + \varepsilon$$

where S is the vector of structural apartment characteristics, C_i are vectors of community characteristics (C_1: landscape and townscape management, C_2: natural amenities,

C_3: accessibility, C_4: tourism and tourism infrastructure, C_5: fiscal and socio-demographic variables) and R is a vector of regional dummies. The dependent variable *RENT* is the apartment rental price. The estimated parameter vectors are α_0 and β_j; ε is a vector of error terms.

We estimated the above model using a straightforward OLS regression approach. Among the common functional forms, a double-log specification provided the best fit. Moreover, this functional form uses the natural logarithm of continuous variables in the estimation and allows an easy interpretation of the estimated coefficients. The coefficients of the continuous variables are elasticities indicating the percentage change in rental price induced by a one percent increase of the exogenous variable. To account for the fact that observations within communities are not independent, we present error probabilities calculated from an ANOVA table in which the effects (mean squares) of the variables are tested against the (residual) variation among communities.

Similar to Geoghegan (2002), we also included the aspect of community location impacts in our model. Our model focuses on property price effects induced by amenity attributes of developed and natural landscape resources such as extensively managed agricultural land or wilderness preserves. We also considered accessibility to control for distance related amenity and agglomeration effects (e.g. Halvorsen and Pollakowski, 1981). Moreover, the specification of our HP model includes a full set of structural apartment attributes.

As Goodman (1989) notes, there may be considerable variation in the price structure of HP models between time periods, making it difficult to aggregate data from different years. However, between 2001 and 2007 (our observation period) the Swiss market for rented apartments was very stable.[1] Moreover, in order to address this problem we include a variable for the year of offer.[2]

Our nation-wide HP model examined how apartment characteristics, landscape and townscape management, historical heritage, natural amenities, accessibility characteristics, tourism-orientation, fiscal conditions and socio-demographical characteristics affect apartment values. Furthermore, we examine possible differences in amenity ef-

[1] According to a nation-wide price index for rented apartments (Wüest & Partner, 2011), yearly price increases ranged between 1.8 and 3.8 percent in the period from 2001 to 2007. In the 1990s and 1980s variation was significantly higher.
[2] The year in which the apartment was on the market.

fects between central and peripheral and between lowland and alpine locations. For this purpose we split the full dataset at the median of the variable for the distance to the next main center and at the median of the variable for the average altitude of a municipality. The analysis of these subsamples helps to understand location specific implicit prices based on different landscape endowment and accessibility.

4.4 Data

The study area consists of 956 municipalities situated all across Switzerland (see Fig. 4.1). These municipalities were chosen on the basis of availability of real estate and environmental data during the investigation period. Data from communities that had been politically restructured in the observation period could also not be used for the study.[3] The municipalities cover the entire rural-urban spectrum except that the five largest cities[4] were excluded from the analysis. Definitions and summary statistics of the variables used in our empirical analysis are provided in Table 4.1. While Switzerland is a small country and major cities are excluded from the analysis, the assumption of one common market for rented apartments is too restrictive. To account for differences in regional housing market equilibria we added regional dummies as explanatory variables (see section 4.4.2).

[3] Especially in western Switzerland many communities merged within the last 10 years.
[4] Zurich, Geneva, Basel, Berne and Lausanne.

Fig. 4.1

Municipalities represented in the dataset.

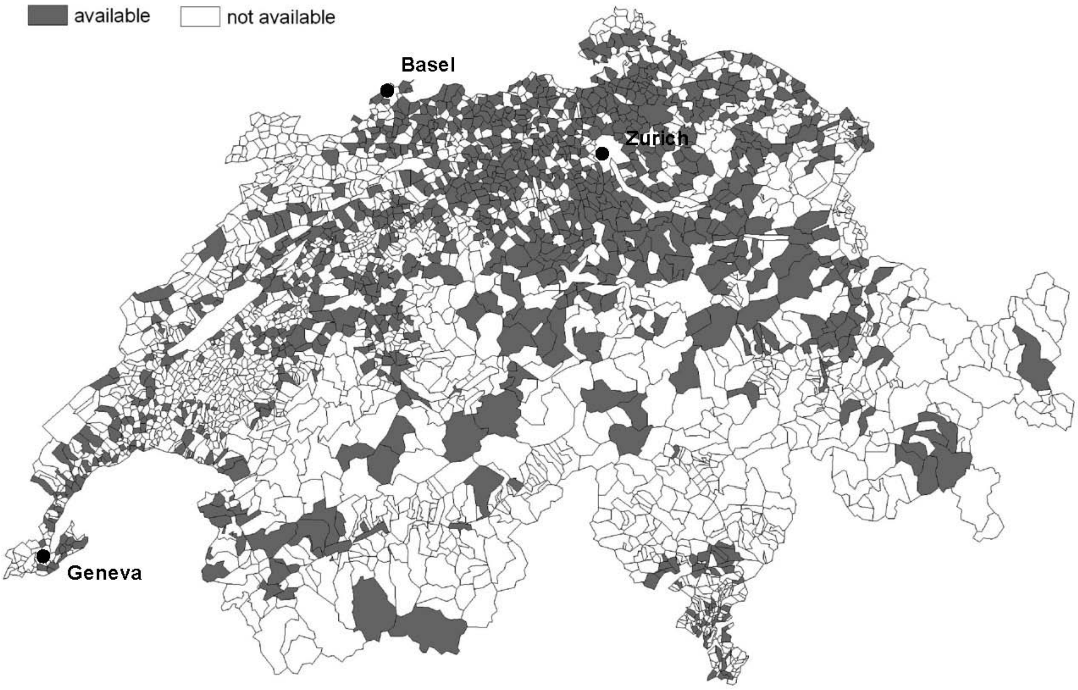

Table 4.1

Definition of variables and summary statistics.

Variable name	Description	Mean	SD	Min	Max
Structural apartment characteristics					
RENT	monthly gross rent of the apartment (in CHF)	1600	708.678	305	9800
LIVINGSPACE	living space of the apartment (in m2)	85.03	33.071	13	370
BUILTYEAR	year of construction	1976	32.908	1500	2007
ROOMS	number of rooms	3.509	1.177	1	10
FLOOR	floor of apartment	1.842	1.611	0	8
OFFERYEAR	year of offer	2005	1.506	2001	2007
LIFT	dummy variable indicating whether the building has a lift (0=no, 1=yes)	0.352	0.478	0	1
BALCONY	dummy variable indicating whether the dwelling has a balcony (0=no, 1=yes)	0.571	0.495	0	1
Community characteristics					
Landscape and townscape management					
OPENSPACE	proportion of undeveloped land among non-forested land in a municipality	0.580	0.119	0.100	0.980

(continued on next page)

(Table 4.1, continued)

Variable name	Description	Mean	SD	Min	Max
NATURALLAND	proportion of high quality near-natural land in a municipality	0.044	0.023	0.003	0.24
HERITAGE	dummy variable indicating whether a municipality is listed in the national inventory of heritage townscapes (0=no, 1=yes)	0.456	0.498	0	1
INDUSTRY	proportion of industrial land use in a municipality	0.025	0.021	0	0.160
RECREATION	proportion of land for recreational activities in a municipality	0.020	0.018	0	0.12
POPDENSHIGH	dummy variable indicating whether a municipality has a high or low population density (0=no for lower than median, 1=yes for higher than median)	0.255	0.435	0	1
Natural amenities					
ALTITUDE	average altitude of a municipality (in m)	535.1	153.017	280.2	3050
SOUTH	proportion of settlement area with southern exposition	0.471	0.282	0	1
SUNHOURS	hours of sunshine per year in a municipality	1519	132.194	1265	2180
MOUNTVIEW	proportion of settlement area with mountain view (restricted to a distance between 1km and 100km)	0.555	0.322	0	1
LAKEVIEW	proportion of settlement area with view to a major lake (surface >100 hectares)	0.182	0.326	0	1
LAKEDISTANCE	average distance to major lake from the centre of a municipality in km (lake surface >100 hectares)	12.428	12.434	0.02	51.77
RIVER	proportion of river area in a municipality	0.009	0.014	0	0.105
Accessibility					
DISTMAINCENTER	distance from the municipality center to next main center (in km) - Zurich, Geneva, Basel, Bern and Lausanne	31.952	34.249	1.396	218.7
DISTREGCENTER	distance from the municipality center to next regional center (in km)	6.696	6.359	0	60.16
RAILWAY	dummy variable indicating whether there is a railway station in a municipality (0=no, 1=yes)	0.737	0.44	0	1
Tourism					
HIKING	length of walking and hiking paths in a municipality (m per ha)	18.712	7.525	0.86	55.741
TOURISM	number of overnight stays in hotels per capita of a municipality	2.753	8.218	0	210

(continued on next page)

(Table 4.1, continued)

Variable name	Description	Mean	SD	Min	Max
Fiscal conditions					
TAXBURDEN	average tax burden (income tax) of a person with an income of 60000 CHF in a municipality (in percent)	8.375	1.695	4.37	13.13
Socio-demographic characteristics					
FOREIGNERS	proportion of foreigners in a municipality	0.212	0.081	0.004	0.46
Regional dummies					
REGIONj (j=1..7)	dummy variables indicating whether a municipality is within a Swiss greater landscape region of "Geneva", "Central Plateau", "Northwest", "Zurich", "East", "Central" and "Ticino" (0=no, 1=yes)	-	-	0	1

4.4.1 Property data

Our main data source was a database of offered rental prices for apartments in the Swiss housing market. The database is based on data provided by the real estate internet portal Homegate. Our sample consists of 80814 apartments offered between 2001 and 2007. It contains rents of apartments offered by various contractors and information on several qualitative and quantitative structural characteristics. The endogenous variable in our analysis is the gross rent[5] of an apartment (*RENT*). Prices of vacant apartments are largely market-driven. They show current market values and conditions. In contrast – due to regulations on the Swiss market for rented apartments – objects with ongoing tenancies tend to show the market value of a former period. Therefore, we only included apartments offered for re-letting and new apartments in our analysis. Although, in the literature on environmental valuation, hedonic regression is usually applied to owner-occupied housing it is reasonable to observe rental prices in the case of Switzerland where 65% of the households live in rented apartments (FSO, 2000).[6] While the rental market is strongest in urbanized areas, it is of high relevance all over the rural-urban continuum. Moreover it covers all market segments from low to top standard. Transaction costs are considerably lower than in the

[5] Including additional costs for heating, etc.
[6] The proportion of owner-occupied housing is lower in Switzerland than in any country of the European Union (see SFOH, 2010).

case of owner-occupied housing, yielding higher market liquidity and providing sound conditions for HP analysis.

The exogenous variables describing the apartment characteristics include the living space of the apartment (*LIVINGSPACE*), the year of construction of the building (*BUILTYEAR*), the number of rooms of the apartment (*ROOMS*), the floor level (*FLOOR*) and the year of the offer (*OFFERYEAR*). Additionally, we used two dummy variables to indicate whether the building possesses a lift (*LIFT*) and a balcony (*BALCONY*).

4.4.2 Community data

Alongside the structural variables, our analysis includes GIS-based municipality-level variables (see Table 4.1). They characterize location-specific amenities and other neighborhood features for the 956 municipalities represented in our apartment data sample. To carry out the analysis we combined the apartment-level and the municipality-level dataset. We differentiate five categories of municipality variables in our analysis: (1) Landscape and townscape management, (2) natural amenities, (3) accessibility, (4) tourism and (5) fiscal conditions and socio-demographic characteristics.

The first category contains variables describing *landscape and townscape management* effects on the apartment rental price. Specifically, the dataset includes a variable for the percentage of undeveloped land among non-forested land in a municipality (*OPENSPACE*)[7], a variable for the percentage of high quality open space/near-natural land in a municipality (*NATURALLAND*)[8], a variable for the percentage of industrial land use (*INDUSTRY*) and a variable for the percentage of land for recreational activities[9] (*RECREATION*). All of these variables are derived from the Swiss land use statistics (FSO, 1997). Additionally, a dummy variable *HERITAGE* indicates whether the municipality is listed in the national inventory of heritage townscapes (Federal Executive Council, 2004).

[7] The definition is based on the categories 1 for forest and categories 11, 12, 13, and 15 for developed land (of the BN 15 data set, Swiss land use statistics with 15 land cover types).

[8] Including the categories 76, 17, 18, 15, 16, 95, 96, 12, 13, 14, 81, 88, 97, and 99 (BN 74 data set, Swiss land use statistics with 74 land cover types) - water shore vegetation, fens, orchards, hedgerows, non-closed forests, extensively farmed agricultural land, unproductive grasslands, and other natural or near-natural landscape elements.

[9] Corresponds to category 14 of the BN 15 data set of the Swiss land use statistics. This category contains golf courses, city parks, camping sites etc.

The second group contains *natural amenity* features that are not subject to landscape management. GIS software was used to create these variables from the Swiss land use statistics (FSO, 1997) and the vector datasets VECTOR25/DEM25 of the Swiss Federal Office of Topography (SFOT, 2004). These include a variable for the average altitude of a municipality (*ALTITUDE*), a variable for the percentage of south-facing settlement area (*SOUTH*) defined as south-east to south-west exposition and a variable for the percentage of municipality area covered by rivers (*RIVER*). We also use a variable for the percentage of settlement area with view to mountains with altitudes above 2000 Meters (*MOUNTVIEW*), a variable for the percentage of settlement area with view to a major lake (*LAKEVIEW*) and a variable for the distance to the next major lake from the center of a municipality (*LAKEDISTANCE*). Climatic conditions are represented by a measure for the yearly hours of sunshine (*SUNHOURS*), which is interpolated using data from 69 Swiss meteorological stations (FOM, 1990).

The third group can be classified as *accessibility* variables. Two variables (*DISTMAINCENTER* and *DISTREGCENTER*) measuring the shortest distance from a municipality center to the nearest main or regional center (IVT, 2006) and a dummy variable (*RAILWAY*) indicating the presence of a railway station in a municipality (SFOT, 2004) are used as proxies for accessibility and the degree of urbanization.

Forth, we include two variables related to tourism: *HIKING* indicates the length of walking and hiking paths (SFOT, 2004) and *TOURISM* represents the number of overnight stays in hotels per capita of a municipality (FSO, 2000).

Fifth, the *fiscal* variable *TAXBURDEN* measures the average income tax burden (federal, cantonal and communal tax) for a married childless person with an income of 60000 CHF (FTA, 2006). Eventually, the *socio-demographic* variable *FOREIGNERS* indicating the percentage of foreigners in a municipality (FSO, 2000) is included to account for otherwise unobservable variation of social heterogeneity and school quality.

Finally, we include dummy variables for the seven Swiss greater landscape regions “Geneva”, “Central Plateau”, “Northwest”, “Zurich”, “East”, “Central” and “Ticino” (*REGIONj*) from the Swiss Federal Office for Territorial Development (SFTD, 2006). These fixed effects were introduced with the intention to reduce omitted-variable bias and account for spatial variation that cannot be explained by the model variables.

4.5 Results

4.5.1 Double-log hedonic model (full dataset)

The regression results are presented in Table 4.2. The last column presents the corrected P-values from the ANOVA (see section 4.3).

The estimated hedonic regression model explains 82.4 percent of the variation in apartment rental prices. All coefficient estimates on the *structural* variables show the expected signs and are highly significant. While apartments on a higher level (*FLOOR*) tend to be cheaper than others, the interaction *LIFT*FLOOR* is positive.

The *landscape and townscape management* variables *INDUSTRY* and *RECREATION* have the expected sign and are highly significant. Apartment rental prices increase with increasing proportions of land devoted to recreational opportunities and they decrease with increasing proportions of land in industrial use. *HERITAGE* also has the anticipated positive sign and is significant at the five percent level. However, we found no evidence of significant effects for *OPENSPACE* and *NATURALLAND*. In order to examine whether population density affects the valuation of open space and near-natural land we also included the interactions of *OPENSPACE* and *NATURALLAND* with the dummy variable *POPDENSHIGH*[10]. The positive effect of the *OPENSPACE* interaction and the negative effect of the *NATURALLAND* interaction indicate that effects of both open space and near-natural land depend on population density.

With two exceptions, the coefficients of the *natural amenity* variables are highly significant and have the expected signs. *RIVER* is only significant in the ANOVA. Moreover somewhat unexpectedly the regression results suggest that mountain view is negatively associated with rental prices. However, the coefficient on *MOUNTVIEW* is only weakly significant and the effect size is low. Overall, the estimates for the natural amenity variables tend to reveal a positive willingness to pay for natural amenities.

[10] *POPDENSHIGH* = 1 if municipality has an above-median population density, = 0 else.

The strongest effect was found for SUNHOURS: a one percent difference in sunshine hours is associated with a 0.46 percent difference in the apartment rent.

Table 4.2

Double-log hedonic model (full dataset).

Variable group	Variable name	Estimate	t-value	P-value		P-anova[11]	
	(Intercept)	-86.090	-13.586	0.000	***		
Structural characteristics	*lnLIVINGSPACE*	0.639	207.822	0.000	***	0.000	***
	lnBUILTYEAR	1.342	36.605	0.000	***	0.000	***
	lnROOMS	0.166	54.002	0.000	***	0.000	***
	lnFLOOR	-0.018	-14.029	0.000	***	0.000	***
	lnOFFERYEAR	10.310	12.386	0.000	***	0.000	***
	*LIFT*lnFLOOR*	0.041	32.538	0.000	***	0.000	***
	BALCONY	0.020	14.109	0.000	***	0.000	***
Landscape and townscape management	*lnOPENSPACE*	-0.053	-8.538	0.000	***	0.631	
	*POPDENSHIGH*lnOPENSPACE*	0.051	4.030	0.000	***	0.013	**
	lnNATURALLAND	0.042	1.731	0.083	*	0.695	
	*POPDENSHIGH*lnNATURALLAND*	-0.039	-10.866	0.000	***	0.000	***
	HERITAGE	0.009	5.373	0.000	***	0.000	***
	lnINDUSTRY	-0.302	-11.079	0.000	***	0.000	***
	lnRECREATION	0.413	11.108	0.000	***	0.000	***
Natural amenities	*lnALTITUDE*	-0.015	-3.492	0.001	***	0.000	***
	lnSOUTH	0.007	3.892	0.000	***	0.000	***
	lnSUNHOURS	0.457	31.030	0.000	***	0.003	***
	lnMOUNTVIEW	-0.003	-1.688	0.091	*	0.000	***
	lnLAKEVIEW	0.044	20.238	0.000	***	0.000	***
	lnLAKEDISTANCE	-0.028	-27.927	0.000	***	0.000	***
	lnRIVER	0.010	0.248	0.804		0.000	***
Accessibility	*lnDISTMAINCENTER*	-0.055	-45.086	0.000	***	0.000	***
	lnDISTREGCENTER	-0.002	-6.883	0.000	***	0.084	*
	RAILWAY	0.012	6.856	0.000	***	0.009	***
Tourism	*lnHIKING*	-0.006	-3.331	0.001	***	0.002	***
	lnTOURISM	0.008	7.898	0.000	***	0.000	***
Fiscal conditions	*lnTAXBURDEN*	-0.328	-57.322	0.000	***	0.000	***
Socio-demogr. characteristics	*lnFOREIGNERS*	-0.126	-15.087	0.000	***	0.000	***
Regional dummies	*REGIONj*	Yes					
Adjusted R-squared:		0.8243					
Number of observations:		80814					

Notes: Significance levels: *** = significant at p < 0.01, ** = significant at p < 0.05, * = significant at p < 0.1

[11] Corrected P-value from ANOVA

The coefficients on the *accessibility* variables *DISTMAINCENTER* and *DISTREGCENTER* suggest the expected positive relationship between proximity to those centers and apartment rental prices. However, essential for the price formation are the major cities rather than regional centers. Moreover, a positive effect can be observed for the variable *RAILWAY* which indicates the presence of a railway station.

The number of overnight stays (*TOURISM*) is positive and highly significant. The negative sign of the variable for the hiking trail density (*HIKING*) is somewhat unexpected, however the effect is weak.

The socio-demographic variable *FOREIGNERS* is significant at the one percent level and has the expected negative sign. The estimate for *TAXBURDEN* suggests that the income tax burden tends to be capitalized in apartment rental prices to a large extent. A one percent increase in income tax burden is associated with a 0.328 percent decrease in apartment rental price.

Furthermore, the dummy variables for the seven Swiss greater regions account for substantial regional differences in apartment rental prices caused by factors not included in our model.

Most of the p-values of the ANOVA confirm and support the significances of the basic regression model, except those of the variables *OPENSPACE*, *NATURALLAND* and *DISTREGCENTER*. In these cases, the OLS model, which assumes independent observations, apparently overestimates the significance of the community variables.

4.5.2 Central versus peripheral locations

Given the significant interactions of *OPENSPACE* and *NATURALLAND* with population density in the full sample model, it is interesting to examine how the estimates differ between central and peripheral locations. It is assumed that the position of a location on the rural–urban continuum and the therewith connected relative scarcity of landscape amenities affect the values of amenities as reflected in apartment prices. Hence, we split the sample at the median of the variable for the distance to the next main center (*DISTMAINCENTER*) and re-estimated the HP model. The results are reported in Table 4.3. We use the same explanatory variables as described in the basis model.

Table 4.3

Double-log hedonic model for central and peripheral subsamples (median split based on distance to main center).

		Central locations				Peripheral locations			
Variable group	Variable name	Estimate		P-anova		Estimate		P-anova	
	(Intercept)	-14.299				-159.3	***		
Structural characteristics	*lnLIVINGSPACE*	0.583	***	0.000	***	0.702	***	0.000	***
	lnBUILTYEAR	2.009	***	0.000	***	1.046	***	0.000	***
	lnROOMS	0.218	***	0.000	***	0.098	***	0.002	**
	lnFLOOR	-0.022	***	0.000	***	-0.010	***	0.000	***
	lnOFFERYEAR	0.351		0.127		20.21	***	0.000	***
	*LIFT*lnFLOOR*	0.038	***	0.000	***	0.036	***	0.000	***
	BALCONY	0.021	***	0.000	***	0.019	***	0.000	***
Landscape and townscape management	*lnOPENSPACE*	0.028	*	0.000	***	-0.085	***	0.002	**
	lnNATURALLAND	-0.024		0.002	**	-0.100	***	0.000	***
	HERITAGE	0.019	***	0.000	***	-0.025	***	0.002	**
	lnINDUSTRY	-0.213	***	0.000	***	-0.290	***	0.000	***
	lnRECREATION	0.092	*	0.000	***	1.091	***	0.000	***
Natural amenities	*lnALTITUDE*	-0.060	***	0.114		-0.007		0.000	***
	lnSOUTH	0.023	***	0.000	***	-0.003		0.000	***
	lnSUNHOURS	0.320	***	0.017	**	0.629	***	0.893	
	lnMOUNTVIEW	-0.013	*	0.000	***	-0.009	***	0.000	***
	lnLAKEVIEW	0.094	***	0.000	***	0.008	**	0.000	***
	lnLAKEDISTANCE	-0.010	***	0.000	***	-0.023	***	0.000	***
	lnRIVER	-0.529	***	0.000	***	-0.022		0.271	
Accessibility	*lnDISTMAINCENTER*	-0.047	***	0.000	***	-0.143	***	0.000	***
	lnDISTREGCENTER	-0.002	***	0.178		0.003	***	0.001	**
	RAILWAY	0.021	***	0.532		-0.009	***	0.013	**
Tourism	*lnHIKING*	0.007	.	0.511		-0.019	***	0.998	
	lnTOURISM	-0.022	***	0.169		0.058	***	0.000	***
Fiscal conditions	*lnTAXBURDEN*	-0.502	***	0.000	***	-0.345	***	0.000	***
Socio-demogr. characteristics	*lnFOREIGNERS*	-0.004		0.835		-0.030	**	0.003	**
Regional dummies	*REGIONj*	Yes				Yes			
Adjusted R-squared:		0.7969				0.8466			
Number of observations:		40407				40407			

Notes: see Table 4.2.

In comparison to the full sample, six of the seven structural variables show highly significant estimates with identical signs. However, the variable *OFFERYEAR* is not significant in the central location subsample.

Comparing the two subsamples, the effects of the variables *INDUSTRY* and *RECREATION* on rental prices are similar in significance and direction; however the effect of the abundance of land for recreation purposes is much stronger for the peripheral locations; most likely because many of the rural communities with a high share of this land-use type are tourism-oriented locations. The effects of *OPENSPACE*, *NATURALLAND* and *HERITAGE* differ between the subsamples. *OPENSPACE* and *HERITAGE* are significantly positive in central communities, but all three variables have a negative sign in the subsample for peripheral locations. *NATURALLAND* is nonsignificant for central locations and has a negative impact in peripheral municipalities.

The *natural amenity* variables have similar coefficients in both subsamples, except the variable for the southern exposition of the settlement area. *SOUTH* has a positive sign and is highly significant in the subsample for central locations, but has no impact on the apartment rental price in the peripheral locations.

The closeness to a main center has a positive effect on the apartment rental price in central and – even more distinctive – in peripheral locations. Somewhat unexpected are the positive effect of distance to the next regional center and the negative effect of railway access to rental prices in peripheral locations. However, these effects are weak. A possible explanation for this result is that locations with the highest rental prices in peripheral regions are tourist destinations which are often remotely located. Finally, *TAXBURDEN* remains highly significant and has a negative sign in both subsamples. The percentage of foreigners has a small negative impact on apartment rents in peripheral locations, while no significant relation was found in the central communities.

4.5.3 Lowlands versus mountains

The subsection above yielded interesting insights on amenity effects as a function of remoteness as measured by the distance to the nearest major city. Another indicator for remoteness and reduced accessibility is community altitude. Communities in mountain regions tend to be far away from national as well as regional centers in the lowlands. Moreover, they tend to have a high abundance of natural amenities and are often tourism-oriented. Hence, we complement the subsample regressions in section 4.5.2 by splitting the data at the median of the community altitude variable (*ALTITUDE*). The results are presented in Table 4.4. Each subsample model explains more than 80 percent of the variation in apartment rental prices.

Table 4.4

Double-log hedonic model for lowlands and mountains subsamples (median split based on altitude).

		Lowlands				Mountains			
Variable group	Variable name	Estimate		P-anova		Estimate		P-anova	
	(Intercept)	-102.400	***			-56.610	***		
Structural characteristics	*lnLIVINGSPACE*	0.616	***	0.000	***	0.662	***	0.000	***
	lnBUILTYEAR	1.779	***	0.000	***	1.050	***	0.000	***
	lnROOMS	0.184	***	0.000	***	0.142	***	0.000	***
	lnFLOOR	-0.026	***	0.000	***	-0.009	***	0.000	***
	lnOFFERYEAR	12.120	***	0.000	***	6.628	***	0.000	***
	*LIFT*lnFLOOR*	0.040	***	0.000	***	0.042	***	0.000	***
	BALCONY	0.018	***	0.000	***	0.020	***	0.000	***
Landscape and townscape management	*lnOPENSPACE*	-0.024	**	0.286		0.011		0.279	
	lnNATURALLAND	-0.124	***	0.000	***	0.200	***	0.000	***
	HERITAGE	0.039	***	0.000	***	-0.013	***	0.000	***
	lnINDUSTRY	-0.212	***	0.000	***	-0.060		0.000	***
	lnRECREATION	0.332	***	0.000	***	0.834	***	0.000	***
Natural amenities	*lnALTITUDE*	0.185	***	0.450		-0.067	***	0.000	***
	lnSOUTH	0.015	***	0.000	***	0.037	***	0.049	**
	lnSUNHOURS	0.215	***	0.943		0.625	***	0.004	**
	lnMOUNTVIEW	-0.012	***	0.000	***	-0.024	***	0.000	***
	lnLAKEVIEW	0.111	***	0.000	***	0.041	***	0.000	***
	lnLAKEDISTANCE	0.002		0.110		-0.034	***	0.000	***
	lnRIVER	0.430	***	0.000	***	-0.842	***	0.015	**
Accessibility	*lnDISTMAINCENTER*	-0.074	***	0.000	***	-0.065	***	0.000	***
	lnDISTREGCENTER	-0.004	***	0.644		-0.002	***	0.000	***
	RAILWAY	-0.012	***	0.138		0.015	***	0.000	***
Tourism	*lnHIKING*	0.004		0.789		-0.037	***	0.000	***
	lnTOURISM	0.001		0.038	**	0.039	***	0.000	***
Fiscal conditions	*lnTAXBURDEN*	-0.183	***	0.000	***	-0.413	***	0.000	***
Socio-demogr. characteristics	*lnFOREIGNERS*	-0.082	***	0.000	***	-0.187	***	0.000	***
Regional dummies	*REGIONj*	Yes				Yes			
Adjusted R-squared:		0.8222				0.8402			
Number of observations:		40407				40407			

Notes: see Table 4.2.

The estimates for the *structural variables* are similar to those in the full sample. The coefficients of the variables have the expected sign and are highly significant in both models. The effects of *landscape and townscape management* on apartment rental prices differ between low- and high-altitude municipalities. The coefficients on *NATURALLAND* and *HERITAGE* show reverse signs in both subsamples. *OPENSPACE* is not significant.

Furthermore, the effects of *SUNHOURS* and *SOUTH* on apartment prices have similar signs in both subsamples while the effect of sunshine duration and dwelling exposition tends to be stronger in mountainous areas. *LAKEDISTANCE* is negative and highly significant in the high altitude sample only. In contrast to that, *LAKEVIEW* is a strong price driver in the lowlands as well. *RIVER* has a positive effect in the low altitude sample and a negative sign in the mountains subsample.

The *accessibility* and *tourism* variables are highly significant in the high altitude subsample. Four of these five variables are not significant in the lowlands subsample. Railway stations and the proximity of regional and main centers have a positive impact on the rental price at a high elevation. Moreover, rental prices tend to be higher in tourism-oriented communities with many overnight stays while such a positive effect could not be observed for the density of the hiking trail network. The fiscal and the socio-demographical variables show the expected signs and statistical significances. In summary landscape and townscape management has different effects on apartment rental prices depending on the altitude of a community.

The following conclusions can be drawn from the five estimated models: firstly, the effects of the structural variables on rental prices differ only weakly among the models. Secondly, the explanatory community variables are connected in a complex way. For instance, distance and altitude effects are strongly connected with the landscape endowment. Thirdly, the differences between the models tend to be stronger for the landscape and townscape management variables than for the natural amenity and accessibility variables.

4.6 Discussion

The results suggest that landscape and townscape management and natural amenities have a considerable impact on apartment rental prices. Over the last decade a variety of studies tried to measure the impact of open space on property prices (e.g. Cho et al., 2008; Geoghegan, 2002; Irwin, 2002; Marshall, 2004; Riddel, 2001; Smith et al., 2002 and Walsh, 2007). In addition to open space we integrated a variable for "near-natural land" into our study. Our results show that open space has a positive impact on apartment rental prices in urban communities. This highlights the population's sensitivity to possible changes in the accessibility and availability of landscape. In contrast, we found limited evidence for positive effects of near-natural land. While this result is hardly surprising for peripheral communities with a high abundance of high quality landscape resources we even found a negative interaction effect with population density. This shows a possible different perception and overestimation of this specific quality variable. A further technical aspect to explain the above phenomenon is that the five biggest cities are excluded from the dataset. Therefore, the scarcity of these high quality landscape attributes is probably not recognized enough. Moreover – in contrast to virtually all comparable studies – we observed rental prices of apartments rather than housing transaction prices. While the Swiss rental market is large and liquid (see section 4.4.1) one can assume that location-specific amenities are more highly captured by prices of residential property where owners tend to invest with the intention to stay for longer periods.

Furthermore, our results suggest that effects of natural amenities and landscape management differ between lowland and mountainous communities as well as between rural and urban areas. This is consistent with findings by Walsh (2007). In line with previous research our analysis suggests that the presence of recreational opportunities and industrial land use is a major driving force for apartment rental prices. For instance, More et al. (1988) emphasized the positive effects of urban parks, while Tyrväinen (1997) also showed that urban forest provides many positive external effects such as recreational opportunities. Nelson (2004), Palmquist et al. (1997) and Smith and Huang (1995) presented evidence depicting the effect of negative localized externalities in industrial areas, such as noise emission, air pollution and olfactory immersion. The pressure on developable land increases the competition between urban and rural areas. The results of our analysis using interactions of population density and open space provide evidence for this urban-rural competition.

It would be interesting to compare our results with other hedonic models of the Swiss rented apartment market. However, we are only aware of one somewhat comparable study. Schaerer et al. (2007) estimated hedonic models for the metropolitan regions of Geneva and Zurich with focus on the valuation of different land uses. Their amenity variables include distance to the lake and view on mountains and lake. While their variable definitions are somewhat different, their findings are quite similar to ours: Schaerer et al. (2007) found that lake yet not mountain view positively affect rental prices. Moreover, their semi-log models imply that houses with an additional distance to the lake of one percent are rented 0.024–0.046% lower; our estimates are comparable (0.028% in the base model).

Our empirical approach has several limitations which possibly cause an underestimation of implicit prices for natural amenities and landscape management. Rather than market property prices our analysis measured the effects of amenities as reflected in apartment rents (see above). Moreover, location-specific amenities may partly be capitalized in wages and not exclusively in property prices (Roback, 1982). Finally, a weakness of hedonic property modeling is the non-consideration of the time-variability of most environmental goods (Freeman, 1993). Housing market inefficiencies and endogeneity of amenities may lead to lags in the capitalization of amenity values (Riddel, 2001).

Finally, on closer inspection of the results for the subsamples (sections 4.5.2 and 4.5.3), self-selection mechanisms might be a considerable reason for some of the differences in strength and direction of amenity effects between remote and central location. For example, the estimated effect of sunshine duration is nearly three times as large in mountain compared to lowland locations. It seems plausible that people who seek sunny climate and landscape amenities tend to reside in or near mountain regions.

4.7 Conclusions

Landscape resources provide a variety of positive externalities. Use values resulting from landscape-related ecosystem services (e.g. the value of access to recreational areas or the value of a sound vista) are reflected in housing prices. Our approach combines apartment and community-level data, and is based on a large dataset at the municipal level in Switzerland. The results of our project are interesting for policy makers, since they help to identify economic benefits of non-market landscape resources on the housing market in Switzerland.

We have analyzed the value of landscape resources as reflected in apartment rents based on a nation-wide hedonic pricing model. It includes structural characteristics, landscape and townscape management, historical heritage, natural amenities, accessibility characteristics and tourism-related variables, as well as fiscal conditions and socio-demographical characteristics.

Our results show that several aspects of landscape and townscape management as well as natural amenities have measurable impacts on rents. In particular, landscape endowment and local accessibility are significant determinants of local attractiveness. The highest implicit prices were found for recreational opportunities and sunshine duration. In line with earlier research we identified differences between urban and rural locations in valuing landscape resources. The results of the submodels support the idea that settlement pressure tends to increase the wish for and the care of natural amenities. Hence, the increasing settlement pressure in urban municipalities heightens the population's sensitivity to possible changes in the accessibility and availability of landscape resources.

Several aspects of these results help to identify research needs. We suggest that future studies expand our set of amenity and landscape management variables and include additional variables for built amenities (e.g. recreational infrastructure). A further topic deserving more attention is the capitalization of environmental amenities in residential housing versus rental prices (see section 4.6). Moreover, we should learn more about the stability of the implicit prices of amenities in a larger time frame. Finally, future research should help to improve landscape and townscape management policies. For instance the different impact of historical heritage on property prices in urban and rural communities requires regionally adjusted political and planning regulation.

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Chapter 5

Conclusion

This chapter contains a summary of how the presented essays contribute to the literature on amenities and regional development. The focus is on the key conclusions, the caveats of the research and the implications of the findings that are relevant to policy makers in Switzerland and elsewhere. In addition, projected improvements and extensions with regard to the unpublished Chapter 4 are illustrated.

The literature on the role of landscape amenities in regional development was reviewed in Chapter 2. The findings imply that – along with traditional locational factors – landscape amenities play an important role in determining the attractiveness of locations. Moreover, implicit prices for landscape amenities, as reflected in property prices, tend to rise with their scarcity and are highest for nature reserves and diverse landscapes. However, while hundreds of voting decisions on open space preservation reveal a high willingness to pay for landscape conservation, the limited empirical evidence for impacts of landscape amenities on employment and income growth is largely concentrated on the U.S. and is lacking in the European context. Considering the sizeable budgets involved in European agricultural and rural development policies, empirical evidence on the role of traditional European cultural landscapes might help decision makers improve efficiency and effectiveness of those policies. Moreover, future research should take endogeneity of managed landscape features into account if it is to contribute to sustainable amenity-based rural development strategies.

The analysis of the role of landscape amenities and related policies for population and employment growth in Swiss municipalities in Chapter 3 contributes to a better understanding of amenity-induced development in Europe. In line with the findings of many studies from the U.S. (see Chapter 2), the results imply that population growth rather than employment growth is driven by landscape amenities and that the impact of managed landscape elements increases with scarcity and income. Moreover, in line with the intention of the legislator to protect valuable landscapes, municipalities with land included in inventories of nationally significant landscapes and townscapes tended to experience decreased population and employment growth. While this is good news with regard to the protection of those amenities, this insight also suggests that the responsibility for financing the management of those amenities should remain with the federal government. Moreover, the finding of positive effects of ecological direct payments on population growth supports the current shift of Swiss and European agricultural policy towards multifunctionality and promotion of environmental services.

Empirical evidence of the impact of natural amenities and landscape management on apartment rental prices is provided in Chapter 4. The findings imply a positive willingness to pay for several natural features of residential municipalities, such as southern exposition, sunshine duration and lake view. Underlining the importance of built amenities (Power, 2005), the abundance of land offering recreational opportunities is a major price driver while general open space matters only in municipalities near metropolitan centers.

A major constraint of the findings presented in Chapter 4 is the low spatial resolution of the landscape, land-use, natural amenity and accessibility variables. While rental prices and structural characteristics were available on apartment level, municipality-level data was used for the remaining independent variables. ANOVA was performed to account for the resulting dependence of observations within the same municipality. The use of apartment level landscape variables (e.g. distance to nearest lake from apartment) would come at the advantage of reduced measurement errors and allow for a sound analysis of amenity effects. For instance, such high resolution variables would allow the estimation of amenity effects on apartment prices as a function of distance from the apartment location (e.g. Luzenhiser and Netusil, 2001; Mansfield et al., 2005). This information may provide indications of whether an amenity (e.g. forest) is rather valued by the residents for its visual and aesthetic qualities or as a source of recreational opportunities. Since the advantages of using apartment-level data are obvious, a projected improvement for Chapter 4 is the construction of apartment-level measures for the landscape/natural amenity and the accessibility variables. This could be done by geo-referencing the apartment dataset with the aid of the included address information and intersecting the resulting spatial data with the land-use and land-cover datasets using GIS software.

Another caveat of Chapter 4 is that potential spatial dependence and spatial autocorrelation is not yet sufficiently considered. Spatial autocorrelation frequently arises in hedonic models and is caused by omitted variables that are correlated over space or by the nonconsideration of important spatial externalities. As a consequence, estimated regression coefficients are inefficient and the standard errors are biased (Anselin, 1988; Munroe, 2007). To address this problem, a further projected extension of Chapter 4 is to conduct econometric tests for spatial autocorrelation (Moran's *I*, Lagrange Multiplier test, LISA). In case the null hypothesis of spatially uncorrelated regression residuals has to be rejected, and depending on the type of spatial autocorrelation, alternative models that explicitly incorporate spatial effects will be specified and estimated. Spatial autoregressive models that are frequently applied to hedonic regression are spatial error and spatial lag models (Anselin, 1988; Can, 1992; LeSage and Pace, 2009).

The extensions of Chapter 4 discussed above should provide valuable additional insights. Information on the spatial distribution of the economic benefits of different amenities will help to improve spatial planning and nature conservation policies by considering welfare and distribution effects and thereby contributing to empirically based public-finance and regional-policy decisions.

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